

# hambrew

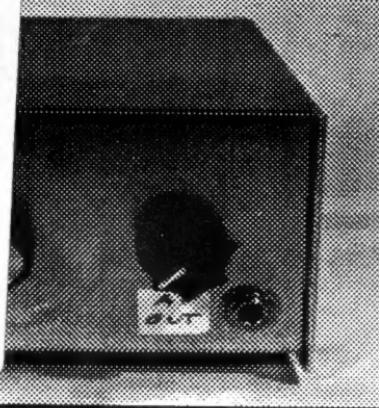
FOR AMATEUR RADIO DESIGNERS AND BUILDERS

N2DCH's



board VFO

GLEN REID, K5HGB  
Sub Exp: 4-96  
1305 CARLOTTA LANE  
AUSTIN, TX, 78733



*The WA6IVC*  
*Hambrew Emergenceiver*

**SPRING 1995**

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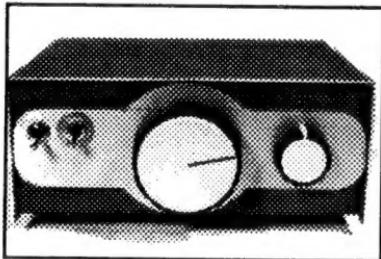
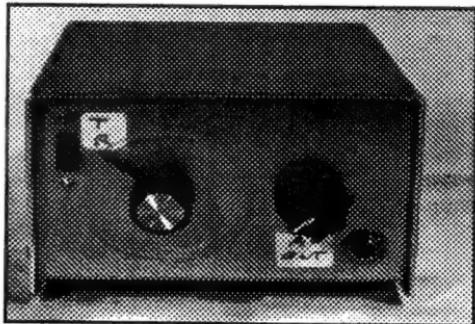
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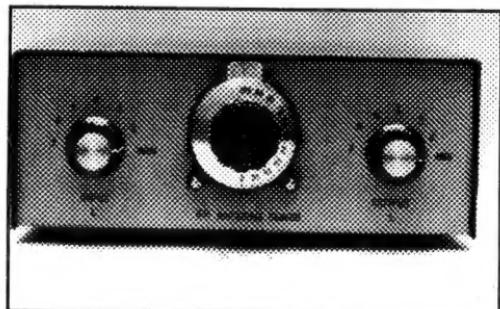
*John Pivnichny, N2DCH  
has brewed up a gorgeous  
outboard VFO for  
his Kenwood Transceiver*

**Bruce Williams, WA6IVC,**  
completes the two-part series on the  
*Hambrew Emergenceiver. This  
little rig could be a life-saver!*



*The 1 watt, VFO Pipsqueak X-2:  
Roam the 40 meter CW  
subbands at will.*

*A very professional-looking  
6 Meter ATU  
from Bill Shanney, KJ6GR*



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#### *Photographic Credits:*

*Front Cover (top), Inside Front Cover (top), p. 13: John Pivnichny, N2DCH; p. 9: S&S Engineering; Inside Front Cover (bottom), pp 16, 21: Bill Shanney, KJ6GR; p.24: Bob Seymour, WØLK; p. 31 (both photos): Reg Tremblay, VE3GQD; pg. 29, 32: Roy Gregson, W6EMT; p.45: Bob Dennison, W2HBE; all others: Hambrew*

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**FOR AMATEUR RADIO DESIGNERS AND BUILDERS**

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SPRING, 1995 • VOL. 3, NO. 2

Publisher.....George De Grazio, WFØK  
Contest Editor.....Bruce Muscolino, W6TOY/3

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Ads & Subscriptions: (303) 989-5642 • Editorial Office: (303) 989-5642

*Hambrew* (ISSN 10773894) is published quarterly by Smoking Pencil & Co., Publishers, Offices at 13562 West Dakota Ave., Lakewood, Colorado 80228.

Second-Class Postage paid at Denver, Colorado. POSTMASTER: Send address changes to *Hambrew*, P.O. Box 260083, Lakewood, CO 80226-0083.

*Hambrew* is sold by subscription and/or back issue only.

\$10 per year (domestic), \$21 (foreign), \$15 (Canada and Mexico)

We welcome submission of articles, photos and manuscripts (S.A.S.E. for return)

## • LETTERS •

### From The Publisher

Well, I guess we get the picture that hambrewers aren't *a priori* contesters for the most part. Our editor Bruce Muscolino has done a very admirable job of designing and presenting some contests that seemed to us to be right interesting and easy to attend, but it seems that great contests do not just happen. Perhaps they result from a building process that happens over a period of time, and they feed on a sense of tradition.

Our sincere thanks to Bruce, however. He has done a great job and we are grateful. It is important to point out that there are no sour grapes on either Bruce's or my part. We just found out that contesting was not the "schtick" of *Hambrew* readers.

One cause to which we are attaching ourselves and the magazine's forum is that of attempting to generate an increase in interest in 6 meter building and operation. The first thought that occurs relative to building, operating and 6 meters is that old bugaboo: interference to our good neighbors watching channel 2! However, when the last good 6 meter opening occurred right at the start of the new year, it seemed to me that the strength of the incoming signals were such that a QRP level of operating might just be the ticket to successful operation in the 50 MHz portion of the spectrum without undue hardship to folks in the neighborhood.

If 500 milliwatts can suffice for communication on 40 meters during good conditions, it should be obvious that it will be more than sufficient power during a 6 meter opening.

Moreover, no publications are picking up the fallen 6 meter banner. It is a delightful though sporadic band that has fallen onto hard times. We will do whatever we can, but you can help by pointing us in the direction of projects that may be available from friends in the hobby

who have built for 50 MHz. If you have heard of any relevant projects or information that we can pass along, please do send it to us, however minor they may seem to you. For our part, we have a great article by Bill Shanney, KJ6GR in this issue, and we are working on a 10 m/6 m dual band receiver based on, yep, the Neophyte. We'll try to have it ready by Autumn, '95.

We must use 6 or we will surely lose it. It was recently reported that President Clinton presented information to Congress that the federal coffers had been increased by a couple of billion dollars earned by the sale of frequency allocations to business interests. This was thought by some to be a really creative acquisition of money as an alternative to taxation. I suspect we can expect more of this type of fiscal bartering for chunks of spectrum in the future.

The other cancer eating at the CW subbands is as least as insidious as the above. I am appalled at the liberties taken by the digital operators moving down-frequency on 40 meters. It is not at all unusual to find crickets as low as 7.040 MHz. Not so long ago 7.060 or above was pretty much the borderline, but not anymore. These squatters are at present laying claim to 20 KHz of turf belonging to Charlie Whiskey. What a shame. Spanish-speaking SSB stations from south of the border are coming down as low as 7.015 MHz, and have even been monitored sitting right on top of WWV at 10.000 MHz....astonishing but true!

Our voice as amateurs speaking to Congress and the FCC is the Amateur Radio Relay League. I hope our readers in the US will support the league, as we have no other significant organized representation whatsoever. I believe that league membership is important (though not solely) for this reason.

Keep building, and thanks for your support of *Hambrew*! - George

Dear Sirs:

1-I have received all back issues of Hambrew and am very pleased. Anyone who objects to six bucks each is short sighted. My first *ARRL Antenna Handbook* costs \$2.00, and I still use it in spite of the latest one on my book shelf for which I spent \$30.00. Your publication will be used for a long time, too.

2-When Lew Smith got a write-up in *QST* for his milliwatt 15 meter xmtr, I sent him a request for more information. Not only did he send me a hand-drawn schematic, but color photos of layouts too. Now that is the kind of attitude that makes ham radio the terrific hobby (avocation?) that it is. I'm working on the rig now.

3-When I prune my wire antennas to resonance, I put the antenna up about ten feet off the ground. At the feedpoint, usually the center, I clip on three feet of coax, take that to my noise bridge and feed that into my TenTec Scout. The Scout is only 5 lbs and a twelve volt battery (from my garden tractor) powers the outfit. I have really had good luck with this method, even though the antenna is close to the ground.

4-I put a decoupler on my 80 meter dipole and I swear that it tunes up better. Could be the ham version of the Hawthorne effect.

Thanks again for the magazines.

Ken Mills - K8AJD  
Kalamazoo, MI

Dear George,

It just keeps getting better. Congratulations on the first birthday! Hope you have many more.

R.E. Hickman, AA5WE  
Copperas Cove, TX

George,

...I have been a HAM for nearly 20 years and had been an avid electronics experimenter since the very early '60s. Although I have been a subscriber to all of the major HAM magazines and several electronics hobby magazines for longer than my XYL would care to remember, I consider the fledgling *hambrew* one of the most exciting and refreshing publications to hit my mail box in a long time. It's wonderful to find projects (especially for my son, N2XHZ) which can be assembled from my ample junk box. The other mags have gone too high tech for the young people coming into the hobby today.

*Hambrew* is going to be a big hit with many members of the HAM club my son and I recently joined.

John R. Ciperano, WA2EBC  
Coram, NY

Hi,

(The subscription is) not quite due yet, but thought I'd go ahead and get it in the mail. Enjoy your magazine a lot even though a lot of it is a little over my head in the technical end. Still enjoy putting projects together and using them even though I don't completely understand why they work.

Would really enjoy an article on the small loop antennas that the Europeans use. Something for QRP in the 30 to 40 Meter band.

Well, enough of that, as I said Good Mag and Good Luck.

Jim Devlin, N5OQV  
Newalla, OK

*Thanks, Jim. We plan to include more antenna designs in Hambrew, and would welcome input on the loop antennas to which you refer!*

## **NEW HAMBREW SUBSCRIPTION RATES:**

**DOMESTIC: \$10/YR.**

**CANADA/MEXICO:  
\$15/YR. (FIRST CLASS)**

**INTERNATIONAL:  
\$21/YR. (FIRST CLASS)**

## Back Issues of Hambrew:

To keep your **Hambrew** collection complete, we still have a number of back issues available. Our Inaugural Issue was Autumn, '93.

Back issues up to and including Fall, '94 are \$6 each, issues published after Fall, '94 are \$3.50 ea. mailed in an envelope via first class mail. The Winter, '95 Issue is sold out and is now a collectors' item. Supplies of the other back issues are limited.

### MOVING?

*Notify us  
of your new address -  
don't miss a single issue  
of **Hambrew**!*

### Now On 80 Meters

This certificate for contact with WFØK is still available. Any QSO with WFØK will now qualify. Now transmitting at 3.560 MHz and 3.710 MHz Sunday evenings at 0400Z.

Simply send your QSL card with the request.  
The certificate will be mailed to you postpaid.



## KIT REVIEW

# Tejas Kits' Variable Peaking Bandpass Filter



*Here's a great-looking kit that really isolates and peaks up that signal you want to hear! The Tejas Kits Variable Bandpass Filter is a good performer in heavy traffic!*

The Tejas Variable Peaking Bandpass Filter kit is a fine-quality kit in an attractive case which has a definite utility in QSOs on a crowded band and/or for use with direct conversion receivers. The parts and components are new quality, and the directions for assembly are clear, concise and easy to follow.

The Model 92150 is a two-stage active CW audio filter with controlled peaking of the center frequency. The filter alone creates no insertion loss, and actually produces gain.

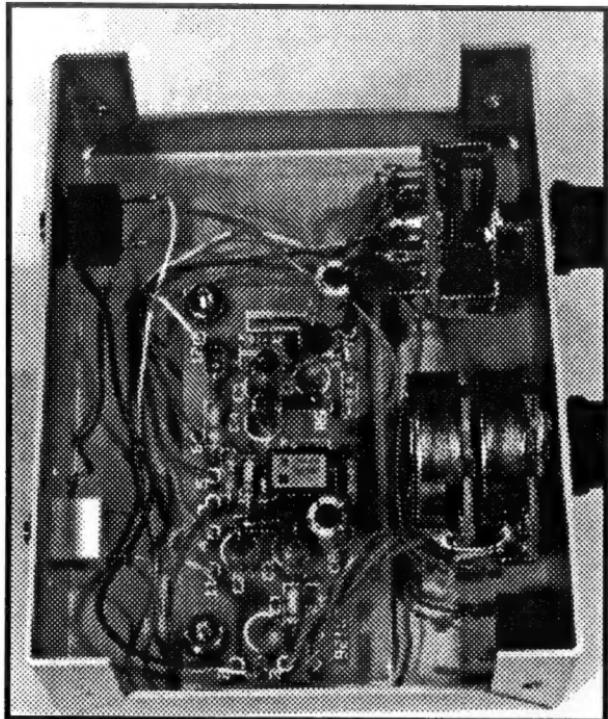
The switchable stages of the primary active device of the filter, an eight-pin TL072 dual op amp, provide an additional luxury in operation. CW width of 300 Hz is variable to 2400 Hz, and there is a bypass. A 2N3904 circuit provides an amplified power output of 400 mw, with options to increase to over 1 watt.

Additional amplification of audio is possible, and circuit options are presented in the construction manual. The current draw is around 20 ma (our measurement) The voltage required is 9 to 12 VDC.

Our kit arrived in good shape, and went together easily. Most of the work of the kit is in wiring to the rotary switch, which is not a problem, and the task goes quickly. Hookup wire is provided in the package. Our kit did lack a knob and some resistors in the kit were of incorrect values, but they were replaced promptly and cheerfully.

The filter worked beautifully on the first power-up, with no unwanted noise or oscillation on the amplifier. It does a fine job of peaking up a desired signal while excluding unwanted ones.

Tejas RF Technology has taken a new



*Not a crowded project box. Plenty of room to work, with a very neat layout. Tejas provides the color-coded connecting wire.*

as they will not be releasing some 26 new kits which were almost ready for market. These were in the price range of \$60 or less. Bill Hickox, the guiding light of the company, has opted to address other, more lucrative commercial market segments of the electronics business.

Admittedly, the proliferation of QRP club kits has had an impact on the ham kit industry. Sales are down for many of the kit companies and Tejas was affected as well. Bill, to his credit and our admiration, does not bemoan the trend but rather is squarely behind the new interest in building for the good of the hobby.

Our loss concerning the kit releases from Tejas is also our gain, as Bill will be writing for *Hambrew* (see the FET Mute Circuit article in this issue), and will give us valuable insights and information about building some of the

never-released kits, as well as some newer projects. For us, this is a silver lining in the cloud.

However it is important to note that, contrary to some stories in circulation, Tejas is not out of business. There are

many Tejas Kits still in stock, and all are still available from the Tejas address below. If the kit we built is any indication, *any* of the kits in the rest of the product line would be well worth having. One that we plan on reviewing is the Tejas Backpacker Transceiver, which, though not a new release, deserves our attention based on comments made by those who have built the unit and are well pleased. We'll keep you posted.

*Tejas Kits  
9215 Rowan Lane  
Houston, TX 77036*

*Price: 49.95 Complete kit including enclosure  
29.95 Kit less enclosure and mounting hardware  
S&H: 4.00*

### *Built a Kit Lately?*

Send us a couple of photos and a review! Let us know how it went together and how it works...we'll pass the word!

# • New Products •

## TAC 1 From S&S Engineering



For those who did not prefer to select a synthesized frequency via a thumbwheel (analog) method of tuning as utilized in the previous S&S offering (the ARK 4 model), here's the sequel you've been waiting for.

The TAC 1 is an 80 meter transceiver with a 32 position, detented shaft encoder for tuning, with an LCD digital display. The encoder has settings to tune in 1 KHz and 100 Hz steps, with the display reading 100, 10, 1 KHz and 100 Hz respectively.

It tunes from 3.500 to 3.750 MHz, and the kit is on two PCBs connected with a ribbon cable. There is no wiring- all jacks are PCB mounted.

The design incorporates a single-signal superhet receiver, and the rig is full QSK. The power out is 3 to 4 watts. Power required is 12v.

A frequency counter is required for alignment, or S&S will do the job for \$29.99.

Case dimensions are 2 1/2"(H) X 5 1/2"(W) X 7 1/2" (D). The price is less than the ARK 4 too: \$199.95 plus \$7 UPS Ground.

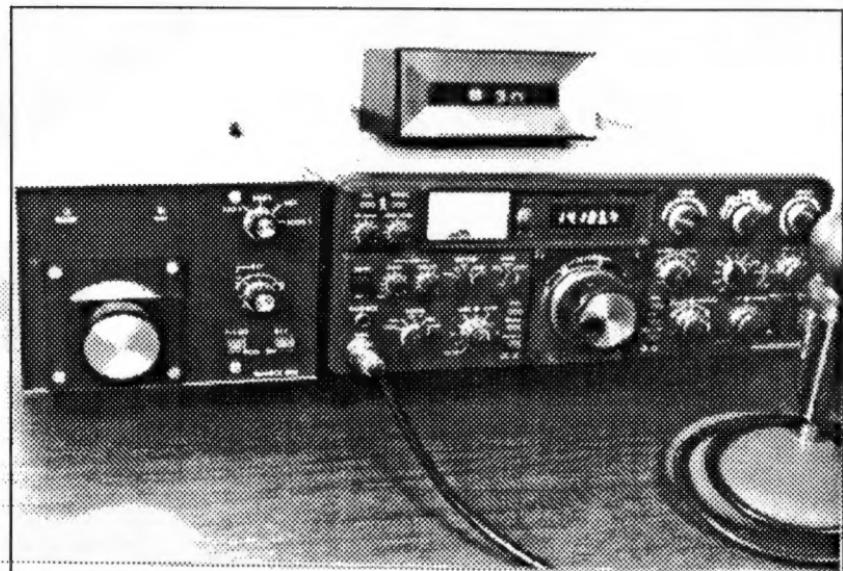
*S&S Engineering*  
14102 Brown Road  
Smithsburg, MD 21783  
(301) 416-0661

**Have a New Product? Send It To Hambrew!**

# A Remote VFO

John Pivnichny, N2DCH

3824 Pembroke Lane, Vestal, NY 13850



The Remote VFO sits "shotgun" to the TS830S  
(Photo: N2DCH)

I use this VFO with my Kenwood TS830S transceiver shown in the photograph. It covers the 5.5-6 MHz range with a low cost highly linear dial and 25KHz per revolution of the large turning knob.

The ingenious ham can modify it to accommodate and match many other transceivers. (The main tuning capacitor taken from a command set transmitter actually covers about 4.8-MHz.) Only a 500KHz portion of this is used in the model described in this article. This tuning capacitor with its 'zero backlash' gear drive is one of the finest straight line frequency capacitors available to the amateur<sup>1</sup>.

In addition to the main tuning dial mechanism, other controls on the front panel provide

valuable operating features. RIT, transmit frequency set, and selection of either main or remote VFO for either receive or transmit (there are four possibilities) are included. Paint colors and panel lettering were selected to match somewhat the Kenwood transceiver I use it with. A combined power/signal cable with an eight pin DIN connector plugs directly into the rear socket available on the Kenwood.

#### Dial Drive Details

The dial is set to cover 4.8-MHZ with 48 turns of exactly 25KHZ per turn. This is the 1.25:1 frequency ratio from last month's article [1]. Only the top 20 turns are actually used. A 2 1/2" diameter dial is constructed to

ride on the main drive shaft and concentric to the main knob. Its style is similar to the Kenwood dial. I used black markings on white bond paper. Figure 1 shows typical markings.

The bond paper is fastened to a 1/4" thick Plexiglas disk. A pulley drive system rotates this disk through nearly one complete revolution while the gear dial drive system rotates about 145 degrees. The pulleys are 1" and 2 5/16" diameter respectively. These dimensions do not have to be exact if the dial cord is strung first, and a temporary dial is marked at 100 KHZ (4 turns) intervals. Then the final dial markings can be drawn similar to figure 1.

Pulleys are constructed from 1/4" thick Plexiglas sheet stock with a hole cutting attachment on an electric drill or with a coping saw. The pulleys are made perfectly round by mounting them on a short piece of 1/4" shaft with a locking panel bearing, and turning them with an electric drill while holding a file against the edge. The pulley groove is also cut in this way<sup>2</sup>. While they are being cut, you should also cut four 1 3/4" diameter disks and the 2 1/2" diameter dial disk from the Plexiglas sheet. A 1 3/4" sheet aluminum disk is also needed. All of these parts are shown in figure 2.

Two 1/4" panel bearings will be required and a 2" length of 1/4 inch shaft. A 1/4" shaft coupling is also required. On one end this is made to fit the capacitor tuning shaft through use of an adapter (spacer). This is made from a brass coupling which normally joins the rear end of the capacitor shaft to a flexible cable. Cut 3/8" off the end of the brass part as shown in figure 3. Then mount it on the end of a 3/16" diameter rod. Chuck the rod in your electric drill and sand down the outside diameter to fit inside your shaft coupling. Drill a small hole to clear the shaft coupling set screw as shown.

### The Box

A sheet aluminum box is constructed to form a rugged mounting for the tuning capacitor and its dial. Aluminum angle stock 1/2" by 1/16" thick provides a strong material for joining the pieces. See figure 4 for details. Check with a local sheet metal shop for the materials. You can ask them to shear the pieces to size. The

box overall is 5"H x 6 1/2"W x 5"D. With feet mounted as shown in the photograph, the box matches the front panel of the Kenwood transceiver. It is held up and tipped back on the operating table at just the right angle to provide a comfortable operating position.

Dark and light gray paint are mixed to match the main transceiver. This is a little tricky if you haven't done it before because the paint will change shade as it dries. A dark gray is needed for the front panel and a one inch border of the top and sides. Light gray covers the remainder of the top and sides. First prime the bare aluminum surface with a metal primer. Then brush on the mixed up paint color. I used Deshler gloss gray enamel #800139 mixed with Rust-Oleum flat black #7776.

White dry transfer letters are used on the front panel to mark the controls. I also used a white drawing ink<sup>3</sup> for the lines. A coating of clear acrylic protects the markings. A dial bezel is cut from 1/8" thick Plexiglas as shown in figure 5. The bottom part is painted on the front side. A portion of the top part is covered with masking tape on the back surface and the paint goes on the back. A line is scribed on the front surface and filled with red magic marker to form the indicator line.

A large knob 1 3/4" diameter is needed for main tuning. Two smaller knobs were selected to approximate the Kenwood style<sup>4</sup>. Two plastic pieces also shown in figure 5 were cut from the 1/8" Plexiglas to form buttons for the RIT and TFSET push switches. They are cemented to the plastic switch shaft with PVC pipe joining cement.

A 3 foot long gray 8 conductor cable terminating in an 8 pin DIN connector join the VFO to the jack on the rear of the transceiver. This length allows considerable flexibility in where the VFO is positioned on the operating table. I prefer to use it on the left side as shown in the photograph.

### The Circuit

An RCA integrated circuit CA3028 generates the 4.8-MHZ oscillations as shown in figure 6. This circuit along with the buffer amplifiers is built on a 3" x 4" circuit board

which is then mounted on the bottom plate of the box underneath the tuning capacitor. The tank circuit, however, is mounted on an aluminum bracket attached to the rear panel in the smaller compartment. Heavy insulated copper wire #12 gauge is used to join the tank components to the circuit board. This includes the main variable capacitor which has its terminal connection near the top of the box.

Glass diodes, type 1N914 are used as voltage variable capacitors to create the RIT (+-2 KHz) shift as well as the 800 Hz carrier shift needed on CW.

A three stage buffer amplifier, isolates the oscillator from the output load. It includes an elliptic filter with a sharp cut off for removal of harmonics. The attenuation characteristic of this filter was calculated on a personal computer using the program<sup>5</sup> by Swiss amateur Dr. Werner Schnider. Results are shown in figure 8.

Power for the oscillator and buffer amplifier comes from the regulated 9V available on pin 3 of the Kenwood external VFO socket. Current drain is 25 mA. Two miniature 12V dial lamps draw their power from the 12v bus available on pin 8.

The control circuit is shown in figure 7. A small 12V relay is switched by the Transmit-Receive switch in the Kenwood via a 12V signal on pin 2 of the VFO socket. A four position rotary switch on the front panel then selects one of 4 possibilities:

- 1-Receive with Remote VFO-Transmit with Main
- 2-Receive and Transmit with Main VFO
- 3-Receive and Transmit with Remote VFO
- 4-Receive with Main VFO-Transmit with Remote

There is also a pushbutton to activate the transmit VFO, without turning on the transmitter, so its frequency can be read on the Transceiver digital display.

#### Adjustment

Final dial mechanical assembly is shown in figure 9 and the photograph. Dial cord joins the two pulleys. All parts should be adjusted

to rotate smoothly. The panel bearings may need to be filed slightly with a rat-tail file to assure the shaft does not drag.

Once the mechanical part is working, power up the VFO either with the transceiver or with an external 9V power supply. Set the low frequency end of the dial to 5.5MHZ by adjusting the tank inductance and the high frequency end to MHZ by adjusting the trimmer capacitor C2. There will be interaction so it is necessary to repeat this procedure several times until both ends are correct. There should be exactly 20 turns of the main knob. At the MHZ end the plates of capacitor C1 should be about one turn from completely open.

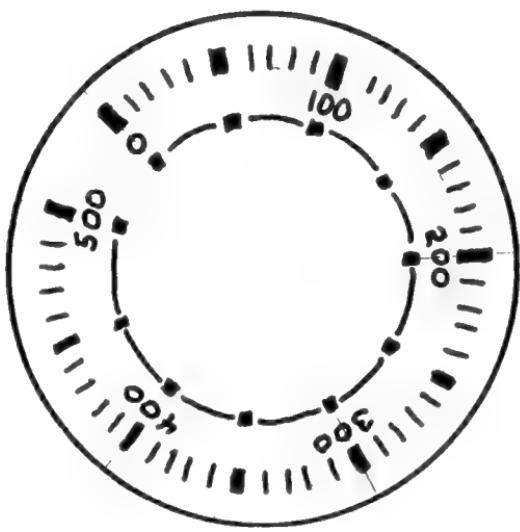
I drilled two small holes in the top cover for adjustment with the cover on. The fixed resistor values shown in figure 6 for the RIT circuit should be satisfactory for a +-2KHZ range. If not, they can be replaced with slightly different values to alter the range covered.

#### Operation

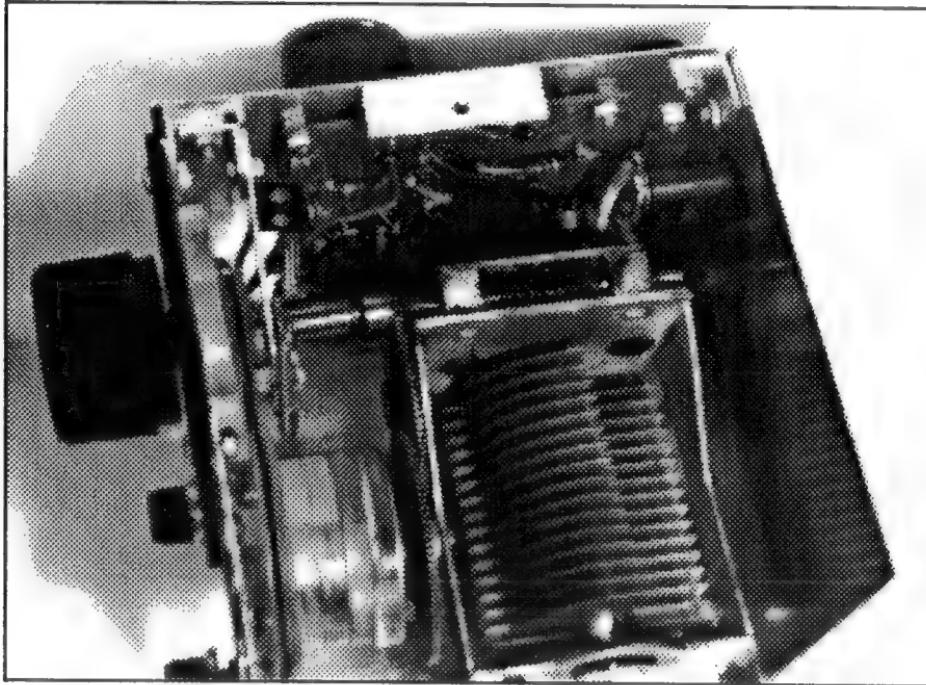
Just plug it into the transceiver VFO jack. Red LED's above the remote VFO dial indicate which VFO is in control. In addition, the red LED above the main VFO lights when it is controlling the frequency. Good luck working "split frequency" DX. •••

#### References

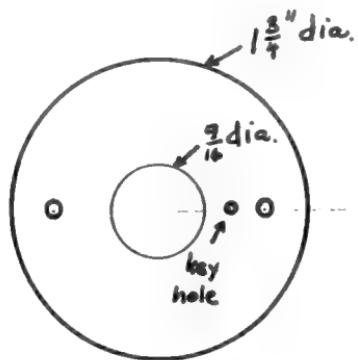
- [1] Pivnichny, John R., "Linear Tuning with a WWII Surplus Capacitor," ham radio, June 1989, pp. 40-48.
- [2] Pivnichny, John R., "A Homebrew Tuning Dial," ham radio, Dec. 1988, pp. 75-78.
- [3] FW non clogging waterproof drawing ink by Steig Products, Lakewood, N. J. 08701
- [4] large knob-Electric Hardware Corp. model EH71-4D skirted round Regent Series. Small knobs-Augat alcoswitch, Andover, MA 01845, part # PKD-60B-1/4
- [5] Schnider, Werner A., "Verify Network Frequency Response with This Simple BASIC Program," EDN, Oct. 5, 1977, pp. 87-89.



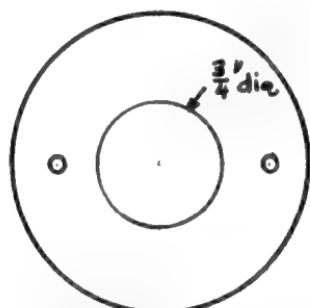
*Figure 1: Dial Face*



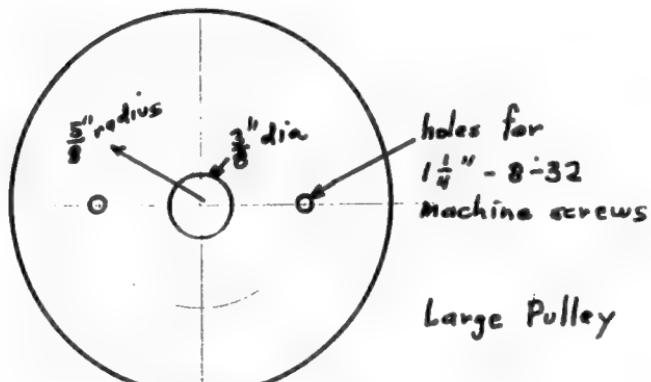
*Interior Layout of the variable capacitor linkage*



Aluminum Disk



Plexiglass Disk (4 required)



Large Pulley

Figure 2: Disks

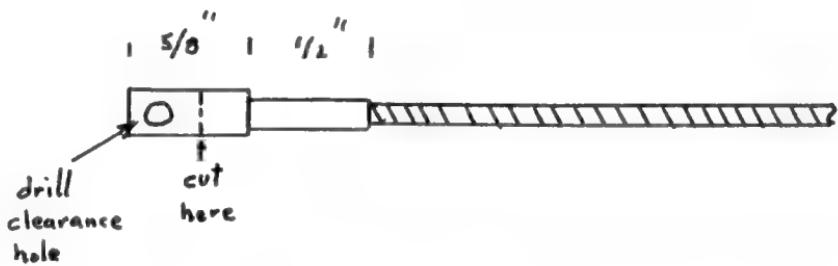
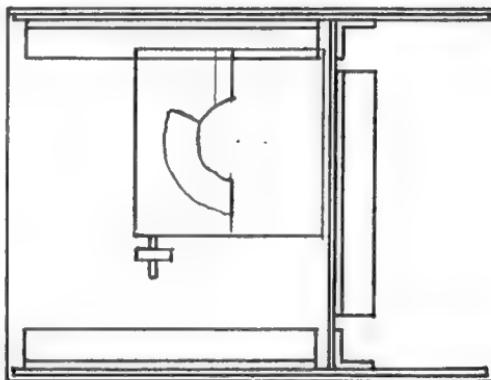


Figure 3: Spacer

Front & Back  $6\frac{1}{2}'' \times 5''$   
 Top & Bottom  $6\frac{5}{8}'' \times 5''$   
 Left & Right  $5'' \times 5''$   
 Partition  $5'' \times 4\frac{3}{4}''$



shaded area  
is removed

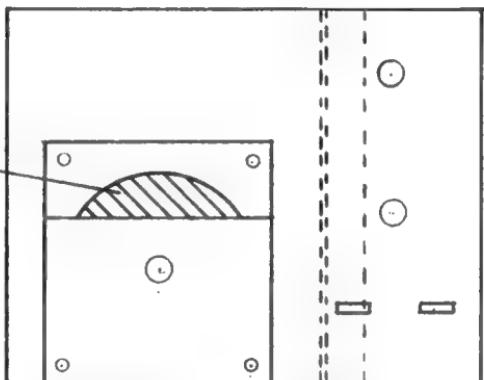


Figure 4: Box Details

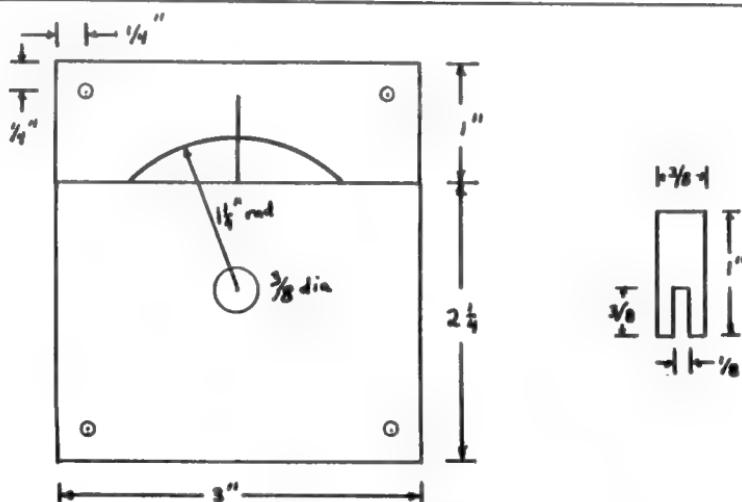


Figure 5: Dial Bezel and Buttons

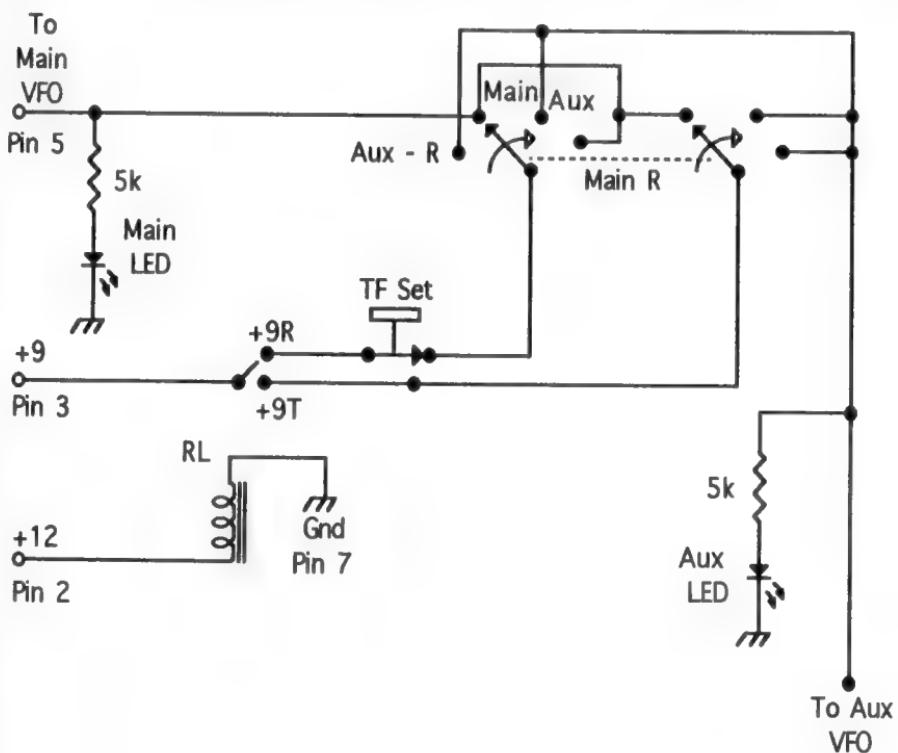
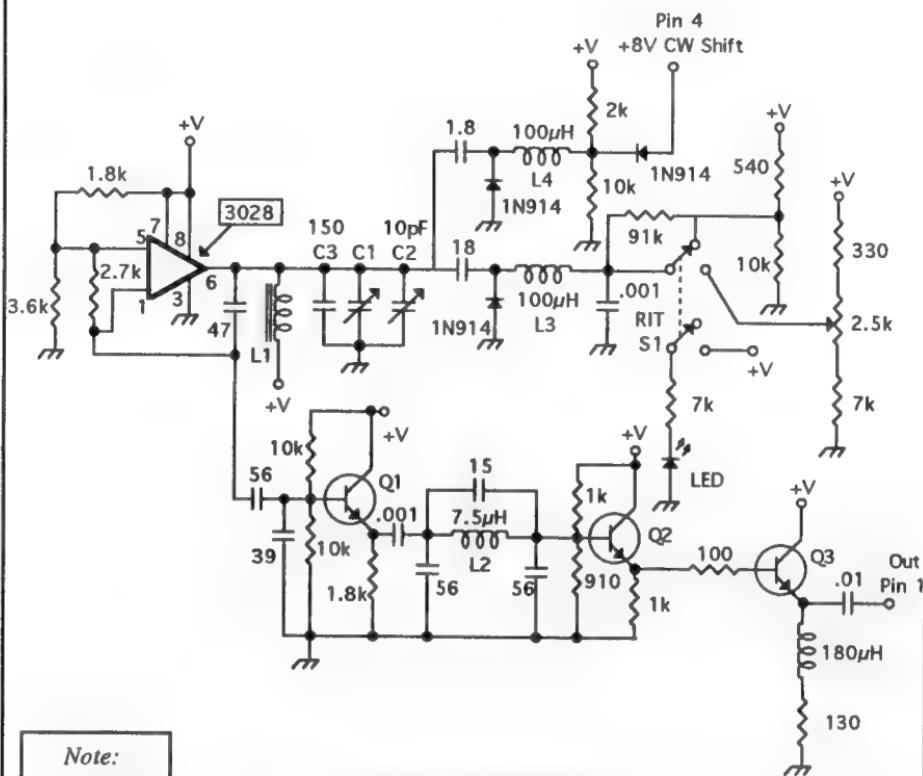


Figure 7: Control Circuit



*Note:  
Article  
concludes  
on page  
42*

Figure 6: Oscillator Circuit

## Parts List

L1 - 20t #22 gauge wire on 3/8" slug tuned form

L2 - 7.5uH 45t #30 gauge wire on high value 1w resistor  
(>300 ohm)

L3 - 100uH, Radio Shack 273-102A

D - 1N914 glass diode, Radio Shack 276-1620

Q1, Q2, Q3 - 2N3904, Radio Shack 276-1603

S1 - miniature power pushbutton, GC Electronics  
#35-492

LED - red 1.8v 2ma, Radio Shack 276-057

RL - mini relay, 12v 40ma 290ohm coil, GC #D1-777

# A Six Meter Transmatch

Bill Shanney, KJ6GR

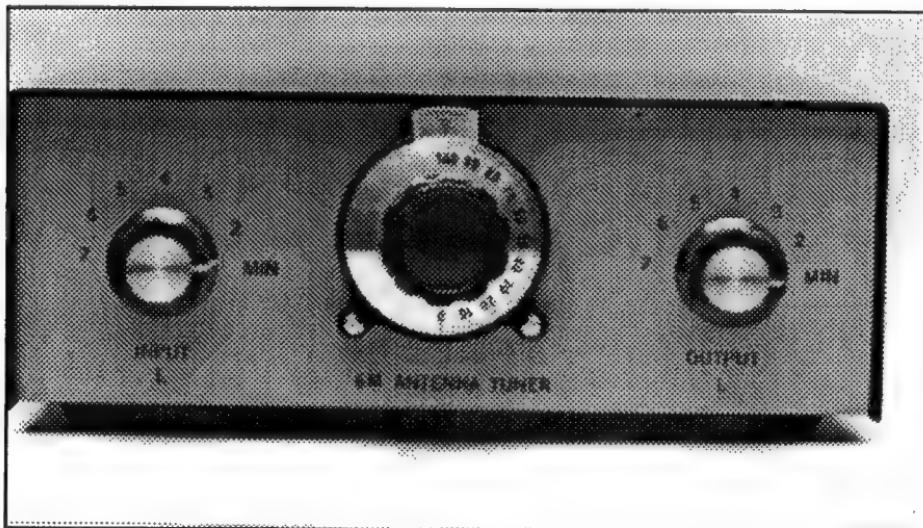


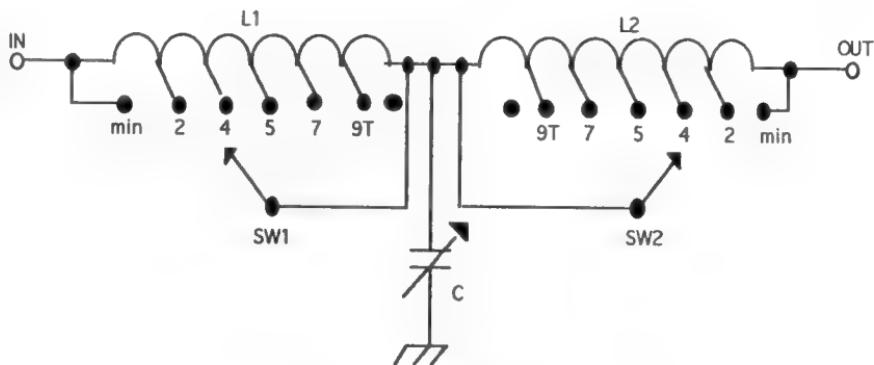
Figure 2: Photo of 6 Meter Transmatch front panel (photos, this article: KJ6GR).

I became interested in six meter operation this year and have been having a lot of fun working DX (i.e.: distant, rare grid squares) during sporadic E openings. The gamma match on my Yagi provides a VSWR of 1.2 to 1.8:1. Now this is not bad but it got me thinking about what I would do in portable operation with a less than optimum antenna if the VSWR was over 2:1. I'm using a Kenwood TS-60 which, like all modern solid state rigs, doesn't like a high VSWR.

The only rig available with a built in tuner that operates on 6 meters is the new IC-736. This fine transceiver uses an internal 28 volt

power supply, which means it won't work from a car battery, and its internal tuner has an insertion loss of up to 1 dB. This translates to 25% of your output power that could be lost heating the components in the matching unit. Since portable operation on six meters is something I want to do and I don't want to lose output power this new rig is not a solution. I decided to build my own transmatch.

There are numerous HF transmatch designs in The ARRL Handbook and The ARRL Antenna Book, but try and find a design for 6 meters. I decided it would be more fun to design my own. I chose the versatile "T"



**Figure 1**  
**6 Meter Transmatch**  
**original schematic and parts list**

L1, L2 B&W Miniductor 3017 Coil stock cut to 12 T ( $1.8\mu\text{H}$ ). Tapped at 2, 4, 5, 7 and 9 turns from connector end (Surplus Sales of Nebraska)

C 0-70 pf air variable (Ocean State Electronics, NP35ND, Dual 35 pf) (any 50 pf variable with do fine).

SW1,

SW2 1 Pole, 6 position ceramic switch modified for a 7th (open) position (Surplus Sales of Nebraska, SWR-L2500)

network used in many commercial HF matching units since it has a wide impedance matching capability<sup>1</sup>. The low pass design, shown in Figure 1, was selected to provide additional harmonic rejection. The network was designed to match a 3:1 VSWR of any phase angle (i.e.: any combination of resistance and reactance). I chose high quality, low loss components to maximize the performance of this transmatch. A schematic and parts list is shown in Figure 1 along with the suppliers. I chose to use new components since at higher frequencies losses due to surface oxidation on older parts can be considerable (and I'm too lazy to clean them properly).

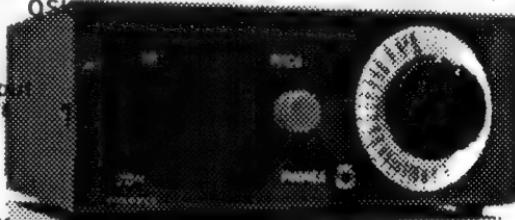
The 6 meter transmatch shown in Figure 2 was built in a TenTec 3 x 8 x 6 enclosure. I used a 10:1 vernier dial on the capacitor to make tuning easier but this was not necessary.

Internal construction is shown in Figure 3. It was more convenient to wire the switches with minimum inductance on the right side. Hind-sight shows that it could have easily been done the other way but I don't feel like re-labeling the front panel for something that is just not important. I modified the switch by moving the stop over one position to allow an open circuit for maximum inductance (position 7).

I verified the tuning range on a Hewlett Packard network analyzer using a 50 Q load and a Smith chart display to plot the input matching range. The range using only the first 4 coil taps was 5 n to 250 Q resistive and out to at least 3:1 VSWR any phase which verified my overly conservative design. I subsequently reduced the total inductance from 1.8 to 0.6  $\text{nH}$  in each coil and moved the taps closer to improve tuning resolution. It now has 7 turns

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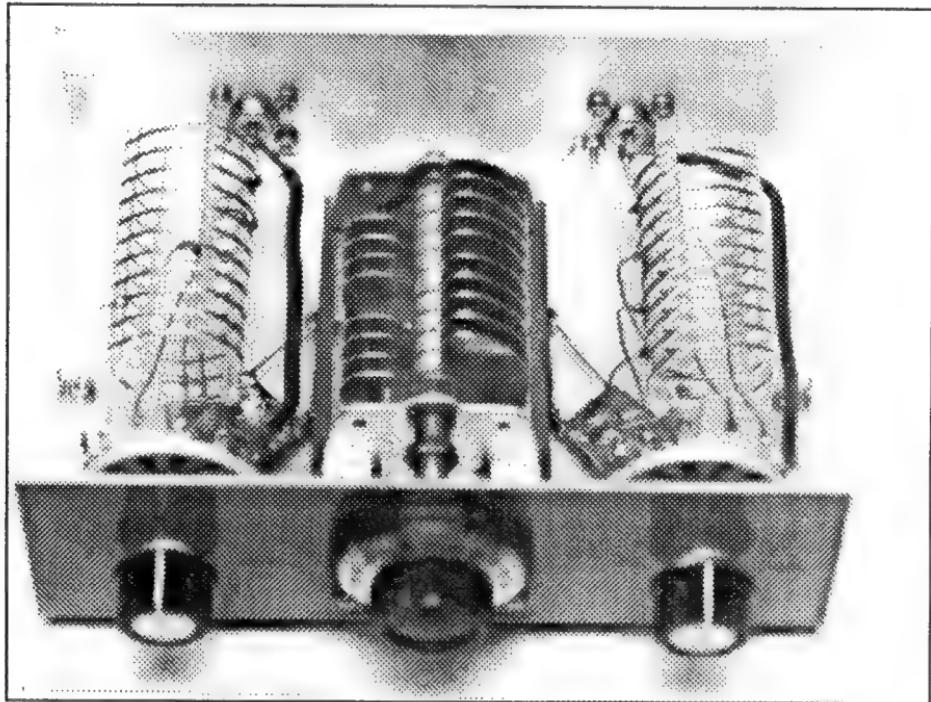
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*Figure 3: Interior view showing original component layout*

with taps at 1, 2, 3, 4 and 5 turns. One Miniductor will make both inductors.

I had a lot of fun designing, building and testing this 6 meter tuner. I hope others find it useful as well. My only addition will be 1:1

current balun, so I can use low loss, lightweight and inexpensive ladder line to feed my portable antennas. I'd appreciate hearing from other homebrewers who have built VHF tuners.

---

## **6 Meter Articles Wanted!**

Six meters is a neglected band. We at Hambrew want to encourage building for and use of the 50 MHz portion of the spectrum.

If interference is a concern, and in many cases it is, we encourage prudent operation on QRP levels, all modes.

Please help us do our part to preserve the 6 meter band through your input. If you or someone you know has designed or built 6 meter equipment, we want to pass along the information.

*Unused frequencies tend to atrophy and disappear.  
Help us help preserve 6 meters for future use.*

---

# Understanding the Simple FET Mute Circuit

## Found in Many Receiver Homebrew/Kit Designs Today

**Bill Hickox, K5BDZ**

I do not claim any originality for this basic mute circuit. Only experience in adapting it to my various needs. And I borrow liberally (Thanks Zack!) from Zack Lau's comments when explaining the circuit he used to modify his "thump suppression" in the HW-9. Zack used a 2N5486 JFET. I used a MPF-102 and the following results are based on my experiences.

**Circuit Description:** The receiver mute circuit in Figure 1 is found in many kits of popular receiver and transceiver articles published over the last decade. It is comprised of C1, C2, R1, Q1, D1 (and Rv).

During the receive cycle, Q1 is turned *on* through bias voltage from U1 output, allowing received signals to pass through Q1 and into the remaining audio chain, such as the AF Amp. When the Gate of FET Q1 follows the Source, and is biased *on*, the FET acts as a resistor with a value of roughly 100 to 300 ohms, allowing signals to pass. During the transmit cycle, AF output from U1 is shorted to ground by C1, and U1 DC bias voltage to the gate of Q1 is grounded through D1, thus Q1 is turned off, thereby *opening* or breaking the audio circuit, keeping the signals from passing, and thus preventing ear shattering clicks or pops into your earphones or speaker.

How it works is simple, and how to better control the timing and thus eradicate "Key Clicks" is also simple if you understand the basics. The output signal from U1 contains

both AF (Audio Frequency) and DC voltage. In Figure 1, we use the DC voltage from U1, through bias voltage dropping resistor R1 (a 1 Meg ohm resistor) to bias (turn on) the gate of Q1 just enough to present an acceptable impedance (100-300 ohms) to U1 output and still pass through the received signals. This bias voltage to Q1 Gate is roughly half the Source voltage to Q1 (bias voltage = Vcc 12). When grounding the Q1 gate, such as keying the circuit to ground, you remove the Q1 gate "turn-on" voltage and Q1 opens, (turns off) thus breaking the circuit and preventing signals from passing. Diode D1 allows positive voltage to pass only one direction (to ground when the key is grounded) and prevents unknowns from entering into the circuit. C1 is basically a bypass capacitor (during transmit) that doubles as part of the timing circuit. C2 is primary in determining the on-off timing sequence of this mute circuit. The secret to making this circuit operate properly in your project is to control the on-off timing of Q1 so as "key-up" you do not get a key-click or "pop" or thump in your speaker or phones.

Fig. 2 is a basic RC timing circuit, where voltage is stored in the capacitor, and the bleed-off resistor is variable, allowing you to determine how long it takes the capacitor to "dump" its stored power and cease to supply voltage to the circuit. The lower the resistance, the faster the capacitor is emptied. We are interested in the *reverse* process, that being "once the capacitor is empty, how long does

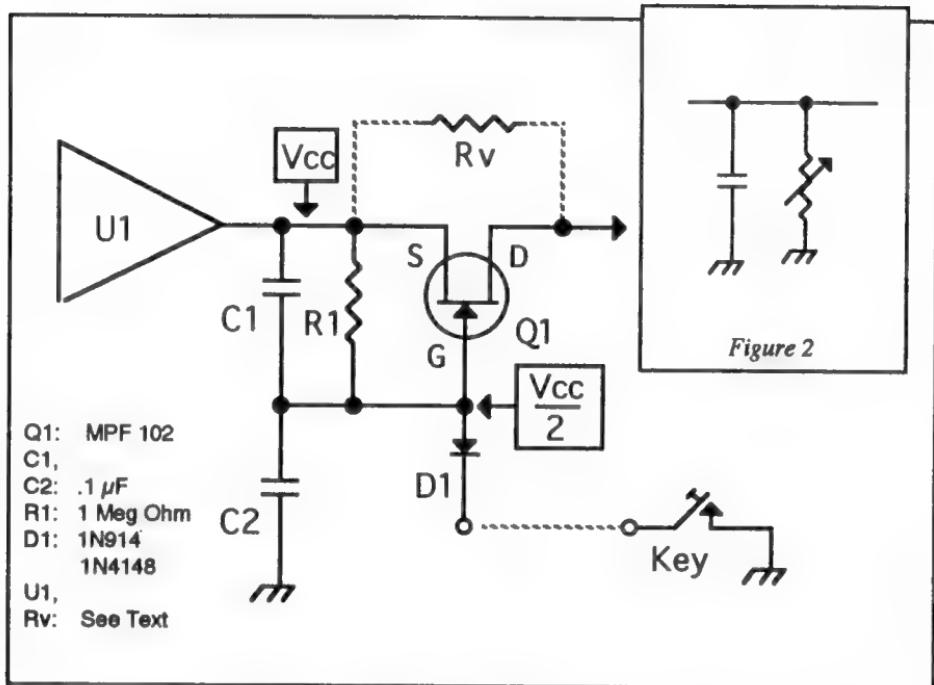


Figure 1

the circuit take to recharge the capacitor?"

**TIMING CIRCUIT:** In Figure 1, C2 is the primary timing capacitor that must be recharged. At key up, the grounding path through D1 is opened (removed) allowing the voltage to return to the gate of Q1, unless the voltage has a lower resistance path to go elsewhere. C2 (now empty from being grounded) is our alternate, lower resistance route for that short time it takes to charge. For the very short time it takes to refill C2, the bias voltage remains removed from Q1, keeping Q1 turned off (open). After C2 is charged, bias voltage to the gate of Q1 turns it on and the received signals are again allowed to pass.

That very short charging time for C2, controlled through the value of C2, keeps the remaining AF circuits blocked while the key clicks and change over "pops" are being "removed".

From my experience (with U1 being one section of a TL072 or equivalent op. amp in a

12 VDC circuit), C1 and C2 values work best if equal. I have found that a .1 MFD value for each C1 and C2 to be most efficient. In extremely harsh cases of key clicks, etc., the value of C2 can be increased to as much as .15 MFD. Larger values for C2 seem to drastically slow the change-over times, and those who like QSK full break-in cannot fully enjoy the feature. (C1 and C2 will also remove some high frequency response from your audio circuit. Although I have found the above values to be very acceptable - in fact, not noticeably changed in AF frequency response - in my applications, you may experiment with capacitor values.)

In the Tejas RF *Backpacker* series of transceivers, C1 and C2 values of .1 MFD normally allow few extremely smooth and fast QSK with no pops or clicks heard. Occasionally, the value of C2 needed to be increased by a very small amount, due to manufacturing tolerances of parts. More often than not, other problems, such as solder bridges and other

minor problems were the actual cause of signals bypassing the mute circuit, with no fault of the mute circuit itself.

Finally, what is  $R_V$  in Figure 1?  $R_V$  is a very high value (usually 2 Meg to 5 Meg ohm) bypass resistor that allows a greatly attenuated transmit signal to bypass the Q1 mute circuit into your audio chain, allowing you to monitor your *actually transmitted signal* rather than use a separate sidetone oscillator for monitoring your keying. This circuit resistor does not meet all needs, so it is included strictly to inform rather than offer specific values.  $R_V$  values should be determined experimentally, and the values given above will give you an idea as to where to start your experimentation.

I hope this has taken some confusion out of the mute circuit used so often by so many. Good Luck in your building. If you have a better circuit, please let me know. I love improvement!

Bill Hickox, K5BDZ  
9215 Rowan Lane  
Houston, Texas 77036

1. Zack's Circuit Improvements - *QRP Classics*, ARRL 1990

## WØLK-BUILT OAK HILLS RESEARCH SWITCHED-CAPACITOR FILTER

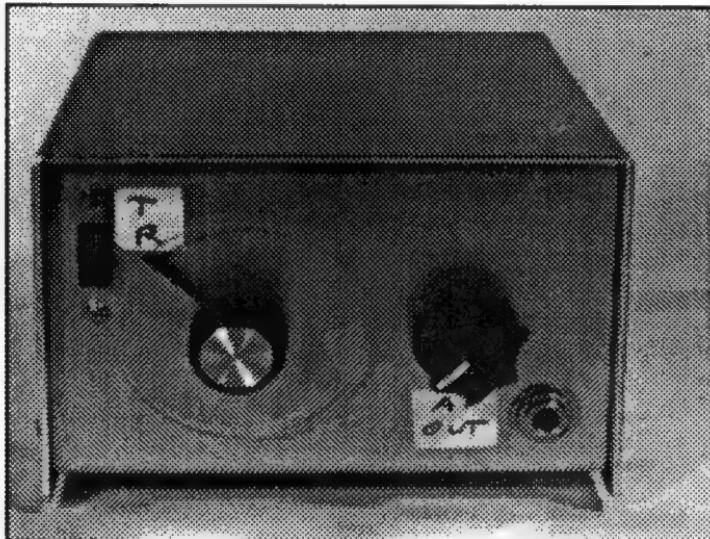


WØLK, Bob Seymour, of Mountain View, Arkansas sends us this peek of a fine-looking kit. If the filter works as good as it looks (and we're sure it does), this is a winner. Oak Hills Research, 20879 Madison Street, Big Rapids, MI 49307, has a number of offerings in it's line of kits, and has a catalog available. Bob shows us inside the project case on page 36.

# Completing the *Hambrew* Emergenceiver

Bruce O. Williams, WA6IVC

MXM Industries, Smithville, TX 78957



*The Hambrew Emergenceiver has a lot to offer in a very small package. At the upper left is the T/R slide switch. The left-hand dial is receiver tuning; the right hand control is AF gain.*

The "Emergenceiver" nomenclature developed between the publication of our last article and this—someone looked at the design and commented "This is just what I need for an emergency rig to carry in the trunk of the car." It took a different shape and purpose from that time on. The board size of the combined receiver and transmitter is now 2-1/2 inches by 2-3/4 inches, and it is housed in an LMB box that is 3" X 4" X 2"—about the size of two packs of cigarettes.

Last installment gave us our first shot at designing and building a small two-to-three watt transmitter. It was an outgrowth of the

Simple TX TX that I have produced commercially for several years. It features a crystal controlled oscillator, and a conventional Class C final amplifier. Nothing exotic—just good ham-experimenter practice. The transmitter I built for the project was constructed on printed stripline prototyping board, and a possible source for that item was given. There was sufficient space left on the board for addition of a simple superheterodyne receiver. This board was only 2-1/2 inches by 2-1/2 inches in size. In constructing the receiver on the board I found an "OOPs". I needed an additional half inch to get the whole

"Emergenceiver" on one board. This required rebuilding the transmitter on a new piece of stripline.

## THE RECEIVER

The receiver is a modification of the Simple SupeRX that I have featured for several years. In the interest of a more economical rig, I made several changes that won't affect the actual performance of the receiver, but do make it considerably cheaper and smaller. Refer to the schematic diagram. I have continued the reference designators sequentially from the transmitter schematic shown in the last installment, so that there is no duplication.

## DESIGN

The Signetics NE602 is used as both a mixer (U1) and a product detector (U2). Although the 602 is bad-mouthed as having a low dynamic range and other problems, I've

found it to be an excellent double-balanced mixer WHEN IT IS USED CORRECTLY. Why some designers use the 602 in a single-balanced configuration, I don't understand. Some say that you really don't need a double-balanced mixer on the lower HF bands—that may be partially true, but it's sure nice to have, and the performance with the double is much better! In this design, U1 is doubly balanced, but U2 is not—more about that later.

U1 uses an external FET oscillator that is a Hartley type, and in U2 the Hartley oscillator uses the circuitry in the 602. One small problem with the NE602 is that it is susceptible to "pulling" in the presence of a strong RF field. When the Emergenceiver is transmitting, there is a high-incident RF field in the cabinet. If a QSK scheme is used, this external oscillator eliminates pulling of the received signal. A Hartley type of oscillator is more stable than the Colpitts type that is more commonly used. These oscillators show almost no discernible drift. Regulating the input

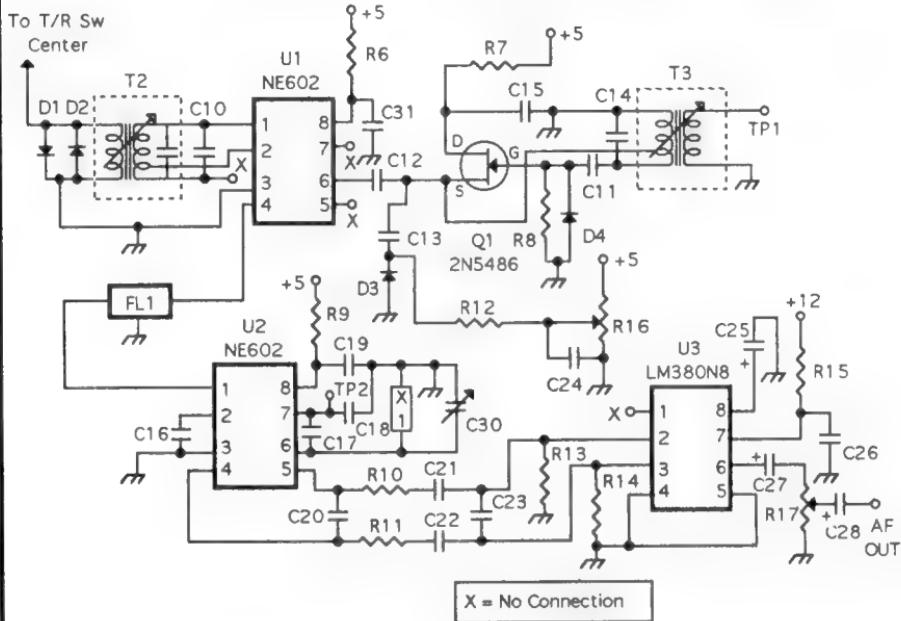
### WA6IVC HAMBREW EMERGENCEIVER PARTS LIST

*The receiver parts list contains reference designators that are sequential to the designators that are used in the transmitter parts list (Winter, '95).*

|             |                             |              |  |
|-------------|-----------------------------|--------------|--|
| C10         | See Chart                   | R6, 7, 9, 15 | 100Ω, 5%, 1/4 W                            |
| C11, C14    | 27pF ceramic NPØ            | R8           | 1 MΩ, 5%, 1/4 W                            |
| C12         | 5pF ceramic NPØ             | R10, 11      | 1.5 kΩ, 1%, 1/4 W                          |
| C13         | 10pF ceramic NPØ            | R12          | 47 kΩ, 5%, 1/4 W                           |
| C15, C19,   |                             | R13, 14      | 10 kΩ, 5%, 1/4 W                           |
| C24, 26, 31 | 0.1μF monolithic            | R16          | 100 kΩ Potentiometer                       |
| C16         | 0.01μF monolithic           | R17          | 25Ω Potentiometer with switch              |
| C17, C18    | 560pF monolithic            | T1, T2       | 10.7 MHz IF Transformer, 7 mm, No. 42IF223 |
| C20, C23    | 0.047μF mono.               | U1, U2       | Signetics NE602AN                          |
| C25         | 10μF, 16V electrolytic      | Double-      | balanced mixer                             |
| C27, C29    | 100μF, 16V electrolytic     | U3           | LM380N8 8-pin audio amp.                   |
| C30         | 5 to 65pF variable          | U4           | 78LØ5 5V miniature regulator               |
| D1, D2, D4  | 1N914 silicon diode         | X1           | 455 kHz resonator                          |
| D3          | 1N4004 silicon diode        |              |  |
| FL1         | LF-B4 Ceramic 455kHz filter |              |  |
| Q1          | 2N5486 FET transistor       |              |  |

Some of the hard to find parts are available from MXM Industries.  
See list at end of article.

## THE WA6IVC HAMBREW EMERGENCEIVER



voltage of the NE602s to 5 volts also adds to the stability. Each NE602 draws less than 5 mA, so there is little stress on the regulator (U4).

The oscillator can operate at either 455 kHz above or below the received signal to result in the 455 kHz IF. Thus, for 40-meters the oscillator will be at 7.455 MHz or 6.545 MHz to detect a 7.000 MHz signal. I use the higher frequency to place the signal in the best position of the 455-kHz ceramic filter (FL1). The LF-B4 ceramic filter has a bandpass of  $\pm 2$  kHz, and together with the additional audio processing between U2 and U3, results in a bandpass of approximately 1.7 kHz—an optimal compromise for both CW and SSB. It would be nice to have a 500-Hz bandpass, but it entails a lot more cost and complexity. A 500-Hz filter costs more than the entire price of the Emergenceiver!

The 455 kHz signal is routed directly from U1 to U2 through FL1. The output and input impedance of the NE602 is about 1,500 ohms. The input and output impedance of the filter is about 2,000 ohms, so the mismatch is negligible, and the reduced cost from not providing a transformer between U1 and U2 is considerable.

One important change I made in the product detector is the use of an inexpensive 455-kHz resonator to control the oscillator. This eliminates the LC network that requires another expensive transformer, and results in a rock-stable oscillator that can be adjusted by C30 to exactly the proper frequency to detect LSB and CW on 40 meters.

The differential audio output of product detector U2 is filtered and centered at about 700 Hz by a bilateral Bessel filter, and applied to the two inputs of U3, an LM380N8 audio

amplifier with a fixed gain of 34 dB. I use the LM380N8 in all my commercial designs because it has sufficient gain and none of the problems that other audio amplifiers exhibit, such as noise and grounding problems. Now remember that we're building a very simple and basic receiver—it is designed as an emergency rig or backup rig, and one of the niceties lacking is a lot of audio output. It is designed to be used with earphones, and will drive a speaker

only if the input signal is at least 1 microvolt. It will provide earphone volume with inputs of as little as 0.1 microvolt! OR—you could use a small amplified speaker such as sold by Naval Electronics in Tampa, Fl. or the "Shack".

C10 makes the input filter circuit (T2) resonant at the input frequency, and C14 makes T3, the mixer-oscillator transformer, resonant at the mixer frequency. Typical values for C10 and C14 are shown below. The value of C10 should resonate T2 at the input frequency. The value of C14 should consider the values of the other capacitors in the external oscillator circuit.

The external FET oscillator is a Hartley type—again for the stability this type of oscillator affords. The oscillator is tuned by a voltage-variable capacitor scheme. This eliminates the need for an expensive air-variable tuning capacitor. The tuning device (D3) is a common IN4004 silicon diode, and any large-current-capacity diode will work. Any diode will exhibit capacitance when back-biased. The IN4004 will allow a frequency excursion on 40 meters of over 200 kHz with a series element of 27 pF—too much for our purposes, so we use a 10-pF capacitor

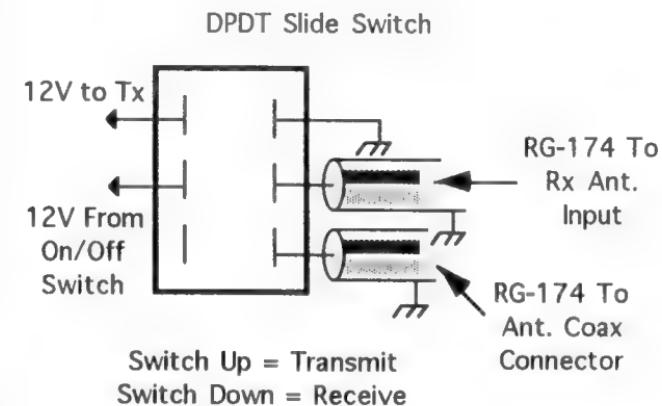


Figure 1: T/R Switch

(C13) in series with the diode. As the back-bias voltage on D3 increases, the capacity of the D3-C13 combination changes to control the mixer frequency. This allows us a tuning range of about 50 kHz, sufficient for the 270 degrees or so rotation of the TUNING potentiometer. We accept the 1:1 tuning of the potentiometer in this case, rather than spend the money for an air-variable tuning capacitor. If you happen to have such a capacitor, and room in your cabinet, you can hook the tuning capacitor to the source of the FET.

#### Typical values for C10, C13 and C14

| Band | Tuning Cap<br>(if used) | C10<br>(pF) | C14<br>(pF) | C13<br>(pF) |
|------|-------------------------|-------------|-------------|-------------|
| 80   | 35-150                  | 330         | 330         | 27          |
| 40   | 4-17                    | 51-68       | 27          | 10          |
| 30   | 2-6                     | none        | none        | 5           |
| 20   | 2-10                    | 27*         | 27*         | 10          |

\* See instructions for modifying T2 and T3.

(Continued on page 34)

# 20/20 Hindsight



— Looking Back Into Past Issues • Updates & Elaborations —



*A stack of W6EMT transceivers, one for each band of 80, 40 and 20 meters, makes a mighty fine looking set of rigs. These were constructed by the designer himself. Our review by WX7K was in the Winter, '95 Issue. The kits are available from Dan's Small Parts and Kits, 1935 South 3rd West #1, Missoula, MT 59801 (photo by W6EMT).*



From Spring, '94



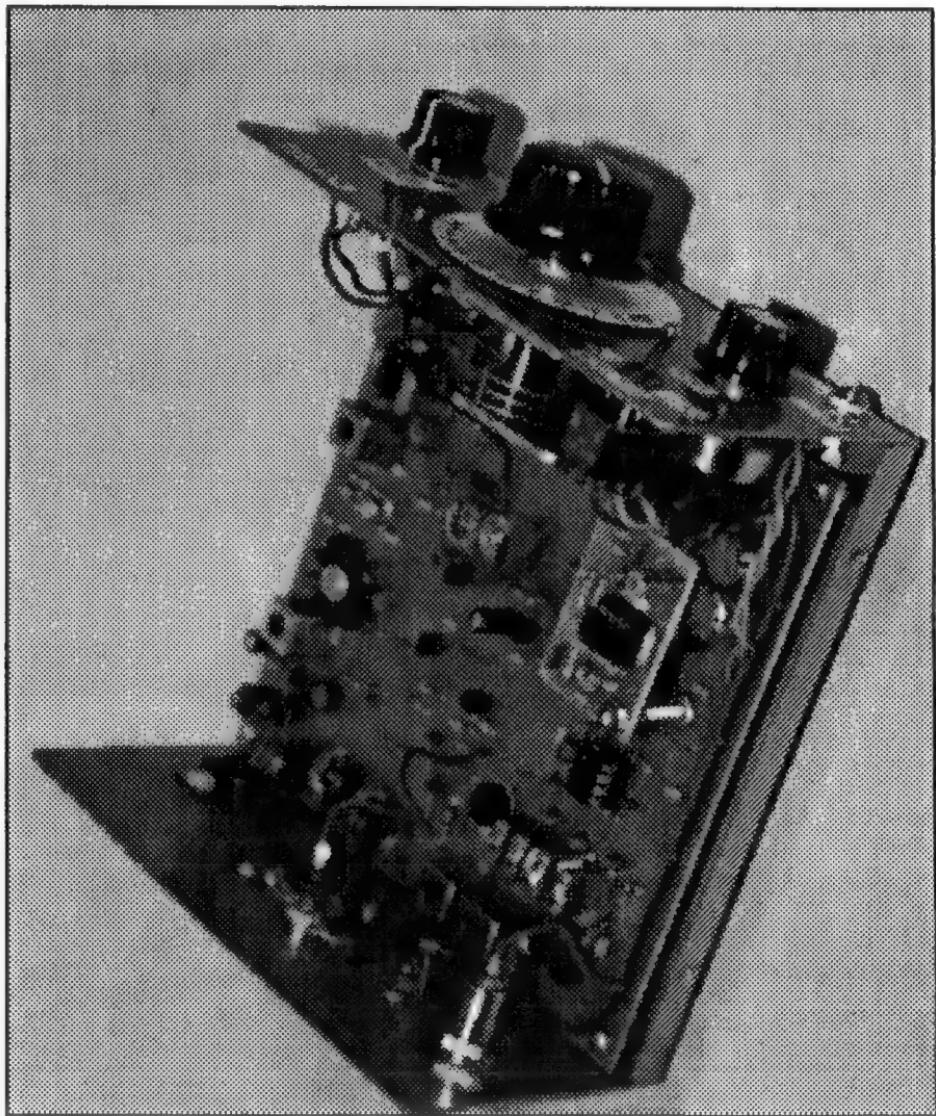
*Very nice work!*

*Built by VE3GQD, Reg Tremblay.  
Top photo shows the K6EIL Receiver with  
bandspread sitting on top of the NG7D  
TwoFCR III Salvation Xmtr (Spring, '94 HB)  
(both photos: VE3GQD)*



20/20

cont.



*Another shot of the W6EMT rig, here showing how nicely it fits into a Radio Shack metal project case- perfect fit! (photo: W6EMT)*



Jim Hale, KJ5TF, sends us this photo of the Lew Smith(N7KSB) transmitter built around the 74HC240 chip. This is the QST version. Jim says "This 15/17m (version) is on a 3 X 3 inch 1-sided PC board. It has 21.110 & 18.080 MHz crystals on a switch with a 15m output network. There is a 25-50 mw loss on 17m... The air variable didn't work, so I went back to the polyfilm variable trimmer".



In the first Hambrew on page 5 is a kit review of the Ramsey 30 meter transmitter. I enjoyed it & hope you will like this Ramsey kit report! My experiment is with the Ramsey QRP-20 CW transmitter. The goal was modification to 15 and 17 meters. I found that the QRP-20 kit will work very well on 15 & 17 meters with small changes. The circuit board has spaces for two crystals, but I got a rotary switch and soldered crystals on it. This gives me all the 15/17M CW coverage I want! I changed C2 from 68 to 33pF & C3 from 330 to 220pF. Q3 was changed to a 2N3866. The output filter capacitors C17 and C18 were changed to 150pF. I removed all but 13 turns from L6. Later on I made a 7 element low pass filter for 21.400 MHz from information in the *WIFB Design Notebook*.

With a simple transmitter like this, you want a simple but effective and efficient DX antenna. I enlarged my old 10M 2 el quad for 15M, at 60 ft. For 17M I really like my Half Square! Its not very high, but my second QSO was New Caladonia in the South Pacific! I run my "fleet" of Ramseys on surplus 17 AH nicad batteries, and charge them with solar

*In the "Shack In A Box" article in the Winter, '95 issue, we referred to a meter circuit that was deleted from the 20/20 Hindsight section of that issue. The information follows:*

### Power Meter Circuit

In response to inquiries regarding meters and some cosmetic techniques applied to projects in issues past: A power meter circuit which I generally use to drive a 0-1 mA meter is one which I modified from the schematic for the VXO Controlled CW Transmitter in the *1987 ARRL Handbook* (Chapter 30, pg. 27). I can attest to its reliable function in showing evidence of power from 10 watts down to 1 watt. I have not tried it below that power range.

The variable resistor works to set the overall level of sensitivity of the meter, and can be replaced with a fixed 1k resistor if desired.

In concert with a reliable wattmeter for

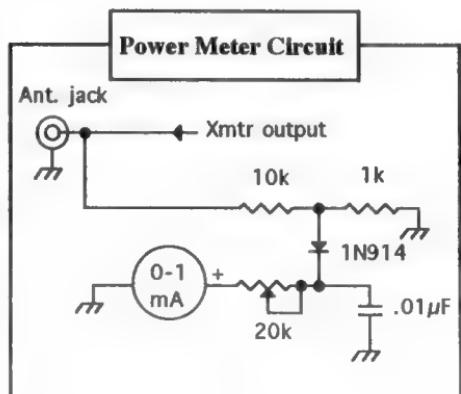


panels. My house is battery powered and wired 12 volt, but the nicad pack makes it more fun! I find that eleven 1.2 V nicads, or seven 2 V lead acid cells are much better, if you're careful not to let the voltage go above 15 V. You can scrounge up some surplus camcorder 7.2 V packs & do very well, or if you want more amp hours than that, Fair Radio has larger nicad cells. If you go with nicads, remember they are more toxic than lead acids.

I would like to hear from other Ramsey kit fans out there and exchange other ideas. I'm presently trying to learn about PLL frequency control to modify some marine VHF FM transceivers which I recently salvaged and repaired. And I hope I can use this knowledge to modify 49MHz FM HT's or even 49MHz cordless phones for use on the 6 meter ham band.

Contact me at HC65 Box 261-B Kingston, AR 72742 or by my packet address: KJ5TF @ NOKFQ.#SWMO.MO.USA.NA

calibration reference, the meter can be relabeled to indicate wattage out for a QRP rig, using a strip of white paper or white drafting tape and a small font size of transfer type (available at art and hobby stores), for smaller edge-type reading meters.



## TRANSMIT-RECEIVE SWITCHING

Because this little rig is not designed for "armchair" operation, a manual transmit-receive scheme is used. After all, and you old cats will remember this, we did it this way for YEARS! A QSK capability would require two more transistors, several resistors and capacitors, three diodes and an RF choke. In addition, and this was the deciding factor, it requires at least another inch of board space! Our scheme is simple. A front-panel mounted DPDT switch is used for all T/R switching. One SPDT set applies 12 volts to the transmitter at the same time that the receiver antenna is removed from the antenna coax connection and grounded. This results in a loud sidetone in the receiver when the transmitter is keyed, but the volume control will reduce the volume. Simple and effective. Using RG-174 for connections to the receiver will lessen the

## RECEIVER CONSTRUCTION

### Tools Required

You will need, as a minimum, the following tools:

Soldering iron, not more than 25-watt rating.

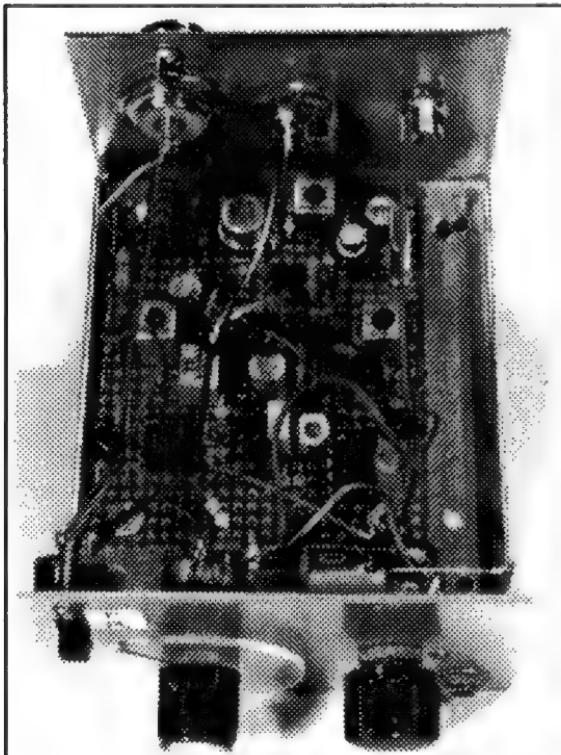
Diagonal cutters.

Long nose pliers.

Small straight-blade and small Phillips screwdriver.

Insulated tuning tool.

... addition, a general coverage receiver, an oscilloscope or frequency counter will be helpful in alignment.



---

*Inside the Emergency receiver: A good fit to the board and project case dimensions.*

---

## ASSEMBLY

Whatever method of construction you decide to use, make sure that you observe the hints that I've given you in the past installments. Clean your board or other soldering surface! Allow extra space for part substitutions or additions. If there is sufficient interest, the editor of Hambrew has offered to stock a printed circuit board and a few critical components that may be difficult for you to locate. See the list of available parts at the end of this article.

## RECEIVER ALIGNMENT

You need no special test equipment to align your receiver. There are only two screwdriver adjustments to the transformers, (T2 and T3), and a screwdriver adjustment to the variable capacitor across the resonator. Use an insulated screwdriver or a tuning tool. Solder pieces of scrap component leads in the test points TP1 and TP2 and use a frequency counter or oscilloscope for a rough calibration. You can also use your ham-band or general-coverage receiver for a rough calibration. Connect a short piece of wire to the receiver antenna and position the wire near the oscillator you are checking. Since we use a 455 kHz IF, the external local oscillator will operate at either 455 kHz above or below the received frequency. Tune the local oscillator to a frequency 455 kHz ABOVE the received frequency on 80, 40, and 30 meters, and BELOW the received frequency on 20 meters. Thus, to get a rough calibration on 40 meters, tune T3 to 7.455 MHz with the tuning control potentiometer at minimum (maximum voltage). Most ham-band receivers have sufficient range to allow you to tune the mixer oscillator.

Aligning the 455-kHz BFO oscillator can be done as described above. If you do not have a counter or oscilloscope, you can use a broadcast receiver. Most BC receivers have a 455-kHz IF. Couple your product detector oscillator to the BC receiver with a short piece of hookup wire loosely wound around or near

the resonator and tune for a zero beat from the BC receiver.

All additional "fine tuning" is done with the receiver mounted in the cabinet and operating. Tune the input transformer, T2, for maximum output on an incoming signal. Fine-tune the BFO oscillator variable capacitor for a SSB signal—if you tune the BFO for a SSB signal, the frequency of the oscillator is properly located near the edge of the IF passband. Tune the oscillator to the LOW side, about 450 kHz, to position the signal at the proper place in the filter passband. Once the receiver is operating, all adjustments can be fine tuned for optimum performance at the frequency of interest.

## ASSEMBLING THE EMERGENCEIVER

The choice of cabinet is up to you. Use an all-metal cabinet to eliminate the effects of hand capacitance. Use the cabinet enclosure for a ground—do not depend on ground wires to give you a solid ground.

## POWER REQUIREMENTS

At high volume the receiver draws about 30 to 40 mA at 12 volts. Although the receiver will operate at 9 volts, it is recommended that 12 volts be used. A 12-volt battery is the optimum source.

## 20-METER TRANSFORMER MODIFICATION

If you wish to put your receiver on 20 meters, a modification is required to transformers T2 and T3. The transformers are normally resonant at 10.7 MHz, and the tuning range of the transformers must be changed to allow coverage of 13 to 15 MHz. There is a small ceramic capacitor in the base of each transformer that must be removed before installation on the board. Break the ceramic capacitor with a small screwdriver or hobby knife and remove all the pieces of the capacitor. Do not try to cut the ends of the capacitor from the recess in the bottom of the trans-

former—You might damage the transformer irreparably. Check continuity between the pins on the three-pin side of the transformer before installing in the board. If there is no continuity, the transformer must be replaced.

## OPERATION

Apply 12 volts to the board. The T/R switch will energize the transmitter and disconnect the receiver antenna from the antenna connector. Key the transmitter and tune the receiver until the transmitted signal is heard—this is your sidetone. You are actually listening to your on-the-air signal and can monitor it for clicks or distortion.

## OPTIONS

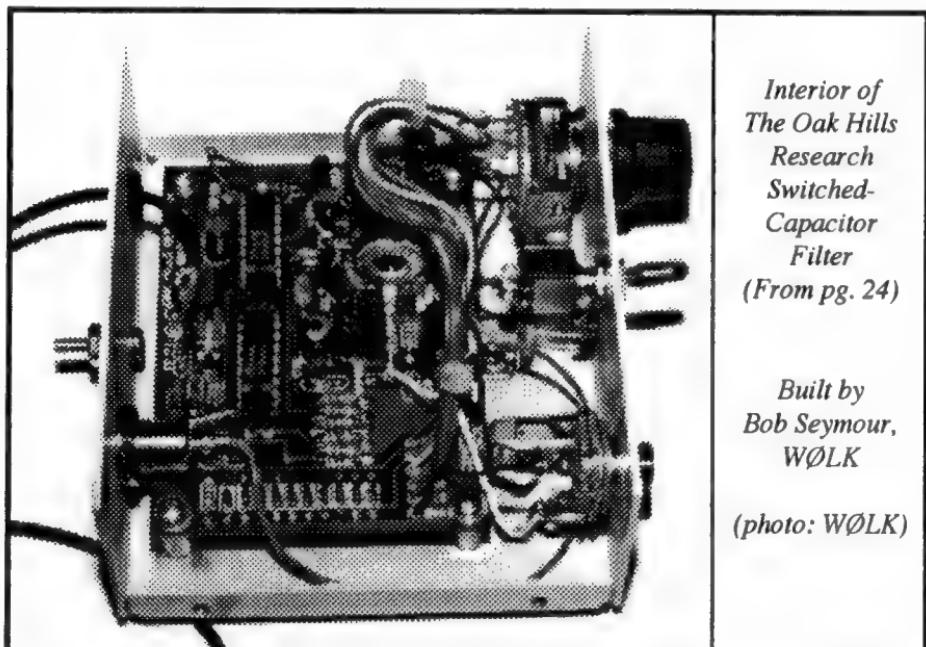
Consider your options! The design of the Emergenceiver is adaptable to many variations. If you can afford the board space, you can install a QSK circuit and get rid of the manual T/R system. You can place a variable

capacitor across the crystal and get more frequency coverage. You can install a simple keyer circuit in the cabinet. You can even have a 1.4 ampere-hour 12-V battery mounted in the cabinet for a self-contained station. Contact me for ideas on how to do these things.

## AVAILABLE PARTS

*As a service to our readers, the following hard-to-find parts are available from MXM industries, Rt. 1 Box 156C, Smithville, TX 78957, at prices shown. Add \$1.50 to each order for shipping and handling.*

|         |                        |        |
|---------|------------------------|--------|
| 42IF223 | 10.7 IF Transformer    | \$1.50 |
| NE602AN | Mixer                  | 1.75   |
| LM380N8 | Audio Amplifier        | 1.00   |
| X1      | 455 kHz resonator      | .75    |
| LF-B4   | 455 kHz ceramic filter | 5.00   |
| 78L05   | 5-volt regulator       | .50    |



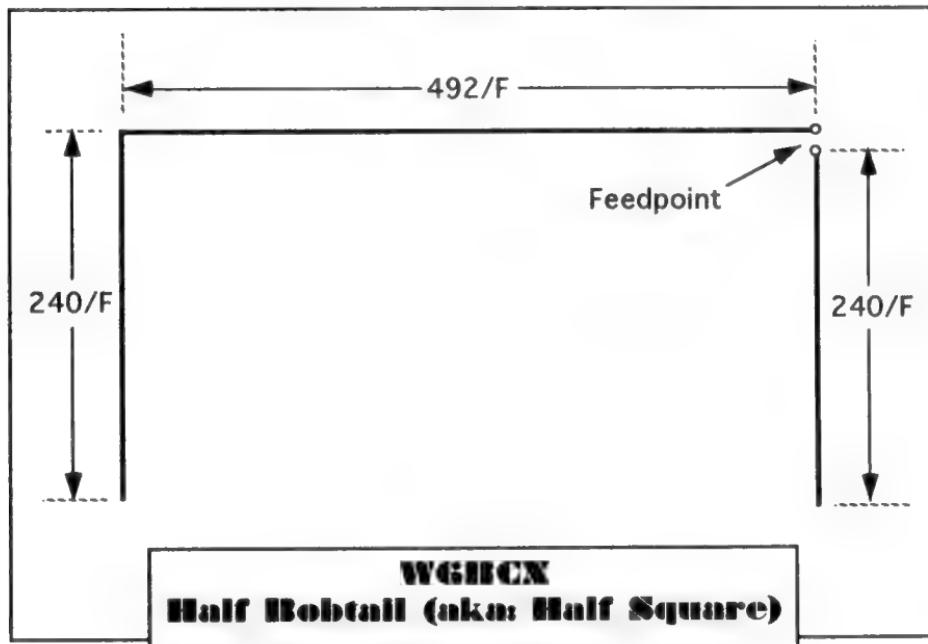
*Interior of  
The Oak Hills  
Research  
Switched-  
Capacitor  
Filter  
(From pg. 24)*

*Built by  
Bob Seymour,  
WØLK*

*(photo: WØLK)*

# Bet My Dollar On A Bobtail

Josh Logan, WX7K



This antenna delivers more good long distance communication per dollar invested (in the wire) than any antenna with which I am familiar. It was originally designed by Woody Smith, W6BCX, after WW II. It is called the half bobtail or the half square, not to be confused with the bi-square. It is simple to construct but a very high performer on DX. Credit must be given to Jim Stevens of AntennasWest who introduced this antenna to me. Jim has marketed assembled and kit versions of the "half square" for years. Jim also sells a nice little tech manual on the theory and construction of "half squares".

It is not the object of this short article to

explain the theory and experiences of users, but rather to introduce and encourage the use of this antenna. Basically it is 1/2 wavelength long, with a 1/4 wave wire hanging from each end. It is a dedicated antenna (one band), and is easily fed with 50 ohm coax in the corner (see figure). You can feed it with 450 ohm ladder line if you wish and use it on other bands with varying results. Unlike its mother the full size bobtail array, one wavelength long, with three 1/4 wave (in phase) verticals, it does not require any radials and can be raised as high off the ground as you wish. Basically, the vertical sections are two inverted 1/4 wave verticals fed in phase. Maximum currents in

each vertical element are at the top - that means maximum radiation is at the top! Computer modeling will verify that much of the energy is radiated at low angles - the higher the array the better long haul operation. This antenna is just as long as a dipole for the same frequency - that is where similarities stop! The array is fundamentally bi-directional and about 4 dB gain over one vertical inverted element. But at low angles it may be as much as 10 dB or more greater compared to a dipole at the same height over ground!

Frankly, I am amazed that I hardly ever talk with half square users. I suspect that folks think anything this simple is not valuable. Let me tell you that a 40 meter half square at 60 or 70 feet elevation aiming at Europe and VK/ZL will really play! This is not a great sweepstakes antenna. It is surprisingly quiet on receive. Once, from southern California, I installed a 15 meter half square at 13 feet (i.e., the height of the horizontal element which does not radiate). The vertical elements were touching ground. Signal reports were 579s out of Europe and Egypt with 50 watts output. Try a dipole at 13 feet above ground - not too swift. Another time, while camping, I put a half

square up at 35 feet and, using 5 watts, snagged a ZS6 in South Africa via long path on 20 meters. At home, I had a 20 meter half square at 40 feet and nested inside it at about 35 feet a 15 meter half square using the same coax line. This worked well on 20 and 15. Using a tuner, I operated daytime 40 meters with excellent success. One morning, I was tuning the low end of 40 meters, then loud and clear a deafening monster pile-up over 3W8CW - a DXpedition of dedicated Hungarians in Vietnam. The Ten Tec Argosy was in QRP position so I threw it into QRO mode (rear switch) - the full 40 watts output. Got him on the second call! I still have no idea what the nested 20/15 combo was doing on 40 meters. But...if it works, don't fix it.

I would love to install half squares for 80 and 40 meters when I live in the country.

*AntennasWest*  
Box 50062  
Provo, UT 84605-0062

*Tel.: (801) 373-8425*  
*FAX: (801) 375-4664*

## *Attention QRP Builders!*

**"Two Fer III" & "NG7D One Der"**  
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**"Two Fer III": \$4.25 per board**  
**"NG7D One Der": \$4.00 per board**  
**(Plus \$1.50 Shipping & Handling per four boards ordered)**

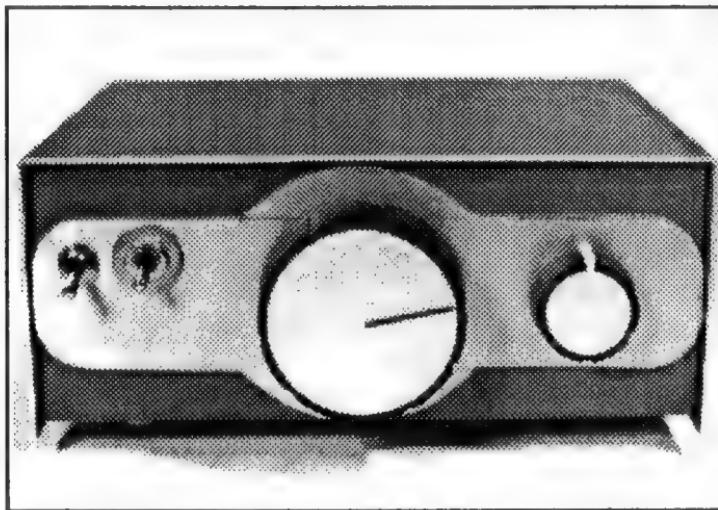
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Available from:  
FAR Circuits  
18N640 Field Court  
Dundee, IL 60118 U.S.A.

I will be also offering an autographed, serial-numbered board set for the two projects for a nominal charge if enough readers show an interest. Details, information: SASE to NG7D, 622 West Alpine Ave., Santa Ana, CA 92707 (sorry, offer must be limited to U.S. amateurs).

## THE PIPSQUEAK RIDES AGAIN

# 1 Watt VFO 'Squeak X-2



*The ramblin' new Pipsqueak awaits a face-job. The toggle switch on the far left is ON/OFF. Next to it is XMT/RCV. The large dial is MAIN TUNING, and on the right is the BANDSPREAD TUNING.*

For little more cost than that of a pair of new crystals, and by adding a Hartley VFO circuit to the Pipsqueak, a frequency-stable range of motion up and down the 40 meter band becomes available.

Build the keying circuit first and confirm that 12 volts are present at the collector of Q6 upon key-down. Then add the driver section of the transmitter and test it with a 7 MHz crystal (see fig. 1 insert, pg. 41). Proceed with the rest of the transmitter and test it with the crystal.

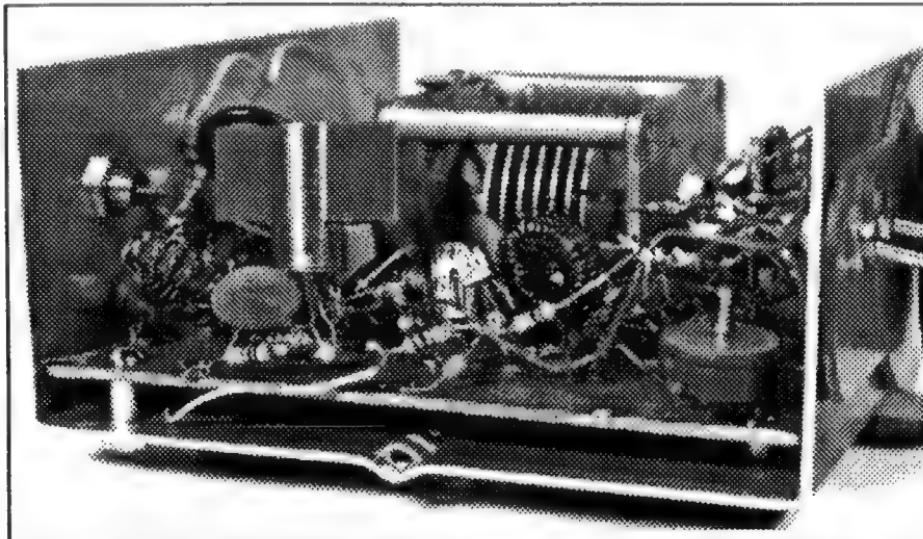
Before constructing the VFO, boil the toroids in water for approximately 10 minutes. I have built several of these VFOs, and have noticed more frequency stability, all things being roughly equal, if the toroids have been temperature-stabilized by boiling them prior (not necessarily immediately prior!) to winding. When winding, remember that each time the wire is passed through the toroid counts as a turn. To further avoid VFO drift, make sure that the capacitors in the frequency-determinate portion (C1, C2) of the circuit are NPØ-

type. Polystyrene capacitors will work also. Other locations for NPØ caps are indicated in the schematic. The VFO section can be monitored on a receiver to determine stability. Expect a 2 to 3 minute warmup before it stabilizes.

Like the original 'Squeak and the Pipsqueak X-1, this version is built ugly-style. If you would like to design a board, feel free to do so, though values may change. With any ugly-built versions, spacing of components can affect capacitance of the overall circuit.

The VFO should be built on a single-sided board. Once constructed and tested, build a box out of pc board for the VFO, or a small aluminum box can be purchased to shield it. The YL's fingernail polish makes a good doping solution for the coils. A coupling capacitor is needed at the input to the transmitter. Try a .05 or a .01  $\mu$ F cap for this purpose.

Though it originally was a QR<sub>P</sub> 50 milliwatt transmitter, you may see by the schematic that the original Pipsqueak now serves as



*The Hambrew version of the X-2 uses a higher-value variable capacitor that was on hand, so the values of C3 and C4 were reduced to 150 pF. A fine-tuning control was added by placing a small value variable cap in parallel with the main tuning (a transmit bandspread).*

merely a driver (Q4) for the final.

The other additions made to the Pipsqueak X-1 incorporated PNP switching transistors Q6 and Q7 for keying the driver and VFO offset. The offset circuit is 'double latched'- an experiment to eliminate the chirp which appeared when the offset was keyed in addition to the driver keying circuit by the same transistor (Q6). Another switching circuit was added with Q7 and the 1N914 diode also in the circuit. It did eliminate the chirp.

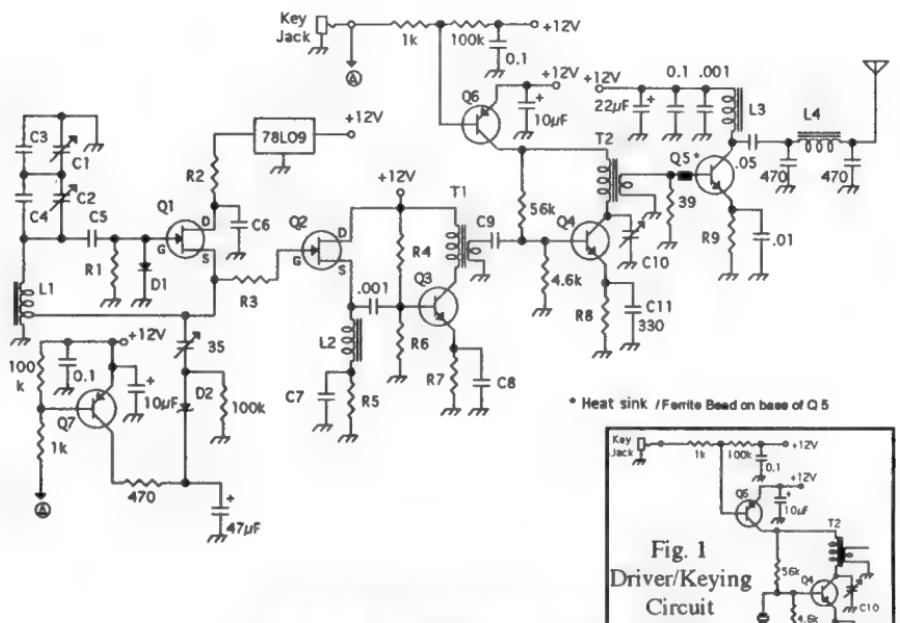
The entire project has come into being through the lashup of several different circuits from other sources. As mentioned in the Pipsqueak X-1 article (Summer, '94), the PA section is from the Universal Transmitter by Wes Hayward, W7ZOI and Doug DeMaw, W1FB (*Solid State Design for the Radio Amateur*, ARRL Pubs.). This particular VFO version is from Bill Heishman, N5HNN and Bruce Auld, NZ5G (QRP CW Transceiver 73 *Amateur Radio*, June, 1989). The offset circuit is a mishmash of W1FB and W6EMT as well as the N5HNN/NZ5G circuitry, keyed with a nice Bruce Williams' (WA6IVC) keying circuit (*Hambrew*, Winter, '95). The offset circuit really throws the oscillator several kHz down

frequency while on receive, and doubtless could be made less cumbersome in design through simplification and different values of capacitance. Other possibilities would include QSK diode T/R switching, a sidetone oscillator, etc. Currently, a Pipsqueak X-3 transceiver using the Neophyte as a receiver section is in the works!

R8 determines the output power of the PA. You may wish to experiment with a different value to suit your needs. A 25 ohm variable might work for variable power at R8, but the leads to it should be shielded to prevent frequency and power instability.

A five-element final filter is recommended. Values for 40 meters are available in the *ARRL Handbook* and *W1FB's QRP Notebook* (ARRL Pubs.). We have driven this version up to 3 watts without much heat from the stalwart 2N3553, but it is most stable with the best CW note at levels below 2 watts output power, ideally at 1 watt to 1250 mw.

By constructing each of the sections and testing each before proceeding, this project becomes manageable and fun. On the air, it is stable after warmup and it's a real treat to get a break from the limitations of being rockbound



## PIPSQUEAK X-2

Fig. 1  
Driver/Keying  
Circuit

|          |  |        |  |
|----------|--|--------|--|
| C1       | 50pF air variable,<br>panel mounted        | Q1, Q2 | MPF 102  |
| C2       | 10 to 12 pF mini trimmer,<br>board mounted | Q3, Q4 | 2N2222   |
| C3, C4   | 200 pF NPO                                 | Q6, Q7 | 2N3866 or 2N3553,<br>use heat sink                   |
| C5       | 5 pF                                       | R1     | 100k   |
| C6, 7, 8 | .01 $\mu$ F                                | R2     | 100 $\Omega$   |
| C9       | .05 $\mu$ F                                | R3     | 10k  |
| C10      | 50pF variable, board mounted               | R4     | 10k  |
| C11      | 330pF                                      | R5     | 150 $\Omega$   |
| D1       | 1N914                                      | R6     | 10k  |
| D2       | 15V Zener                                  | R7     | 1k   |
| L1       | 34 turns T50-6, tap 8 turns<br>from ground | R8     | 3.3 $\Omega$ (see text)                              |
| L2       | 15 $\mu$ H                                 | T1     | Primary: 15 turns # 26<br>on FT 37-43                |
| L3       | 22 $\mu$ H                                 | T2     | Secondary: 3 turns over<br>collector end of primary  |
| L4       | 14 turns #22, T50-2                        |        | Primary: 35 turns #26 on<br>T50-2 Secondary: 4 turns |

**SPECIAL To HAMBREW Magazine...**

# OCEAN STATE LIVES!!!!

**Bruce Muscolino, W6TOY/3**  
**PO Box 9333, Silver Spring, MD 20916-9333**

Contrary to a very nasty rumor making the rounds of the QRP List on the Internet and elsewhere as well, Ocean State Electronics is alive and well in Westerly, Rhode Island. This morning (March 23, 1995), I spoke with Frank Pelicano, the owner of Ocean State to discover the facts about the rumor that showed up on the Internet's QRP List back in January of this year.

According to Mr. Pelicano, the rumor apparently can be traced to a misunderstanding with a customer regarding an order for parts that Ocean State no longer carried. Mr. Pelicano told me he has been systematically restructur-

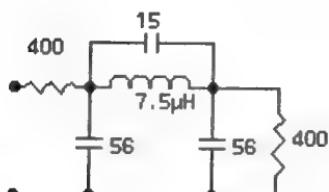
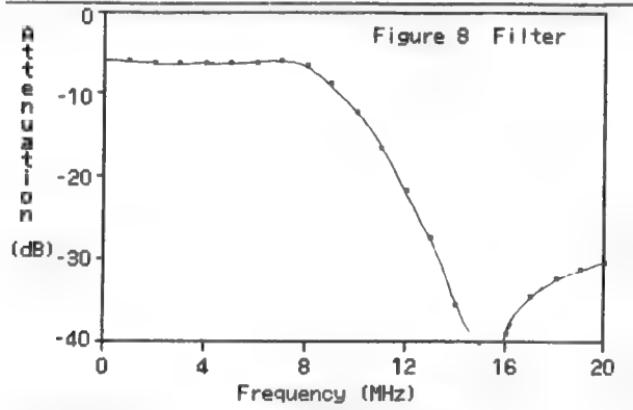
ing the product lines Ocean State carried to remove those product lines that are no longer profitable. However, this should have little on no effect on the products that the *Hambrew* community generally orders.

Ocean State has just published a new catalog reflecting the product lines it currently carries. I've asked for a copy and maybe you should too. Remember to tell him *Hambrew* sent you!

*Ocean State Electronics*  
PO Box 1458, 6 Industrial Drive  
Westerly, RI 02891

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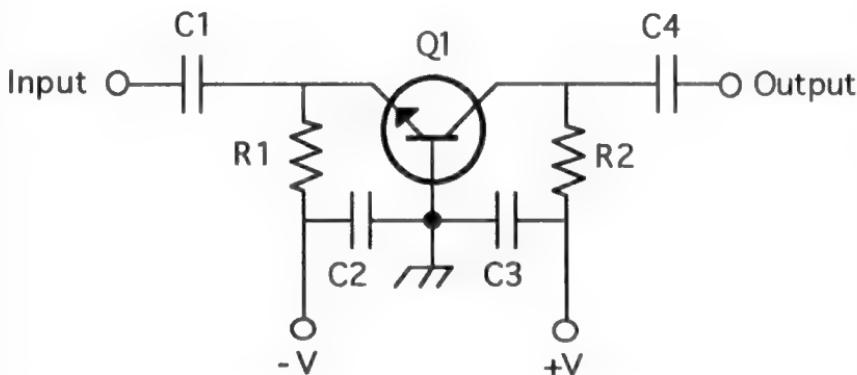
*Remote VFO (cont. from pg. 17)*



**DESIGN BASICS SERIES**

# Thoughts On Theory

**James G. Lee, W6VAT**



*FIGURE 1: Typical Common-Base Amplifier*

## TRANSISTOR CHARACTERISTICS

Before I get much further in this series, we need to discuss some of the more important transistor characteristics which impact the choice of transistor type, which circuit to use, and how it is biased. Although there are three circuit configurations that can be used with bipolar transistors- the common base, common-emitter, and common-collector configurations- the common-emitter configuration is most often used. The common collector configuration, often called the emitter follower configuration, is the next most common, and while there are uses for the common-base configuration, it is rarely used in modern equipment.

## THE ALPHA OF A TRANSISTOR

The most important characteristic of a transis-

sistor is it's alpha (or  $\alpha$ ). It is a measure of the quality of the transistor, and normally has a value close to 1 or unity. There are both AC and DC alphas, although they are often nearly the same. Alpha is the ratio of the particular transistor's collector current to it's emitter current, and is written simply as:

$$\alpha = I_C/I_E$$

Recall that the emitter current  $I_E$  is the sum of both the base current  $I_B$  and the collector current  $I_C$ . So the greater the collector current for a given emitter current the better the quality of the transistor.

In the real world most transistors have  $\alpha$ 's = 0.95 to 0.999. That is, their collector currents are at least 95% of the emitter current with many being 98 - 99% of the emitter current. Note this is a DC  $\alpha$ , and is normally applied to

the common-base configuration. There is an AC  $\alpha$  as well, and is the ratio of a small change in collector current  $i_c$ , to a corresponding small change in emitter current,  $i_e$ . These two values of  $\alpha$  are normally quite close together with the AC  $\alpha$  also falling in the range of 95 - 99% of the emitter current.

For those of you not too familiar with notations on such things as emitter current, there are both AC and DC notations as well. When talking about DC notation, upper case (or capitalized) subscripts are used such as  $I_E$  for DC emitter current. For AC notation, lower case (or small letter) subscripts are used, such as  $i_e$  for AC emitter current. In this manner you can keep track of what the notation is telling you - whether it is a DC or an AC value of some particular characteristic of the transistor. The actual unit symbol may or may not be given the same treatment.

### THE BETA OF A TRANSISTOR

When we move to the common-emitter transistor configuration, another characteristic which denotes the quality of the transistor is called beta (or  $\beta$ ). Beta is the ratio of the collector current to the base current. I emphasize "base" current because the signal input point in the common-base configuration is the emitter lead, while the "base" lead is the signal input point in the common-emitter configuration. PICTURE 1 shows a typical common-base stage with the input applied to the emitter lead.

Alpha and beta are related by the following simple equation:

$$\beta = \alpha / (1 - \alpha).$$

The closer  $\alpha$  is to 1, the greater the value of  $\beta$ . For example, if a transistor's  $\alpha = .99$ , then it's  $\beta = 1/0.01 = 100$ . It is not uncommon to find transistors with  $\beta$ 's of 250 to 300. Unfortunately, betas can vary widely between transistors of the same type, and this can cause problems in designing and troubleshooting transistor circuits. This is due mainly to manufacturing tolerances. Often a manufacturer will

characterize his transistors using a technique called "beta spread". If the transistor type has an overall beta spread of say 100 - 250 due to manufacturing tolerances, he might classify them into three differently numbered units with one group having a beta spread of from 100 to 150, the second group having a beta spread of 150 to 200, and the final group from 200 - 250.

There's nothing wrong with this type of classification, and it is partly responsible for the fact that we have over 6000 different transistor types. If you have to replace a particular transistor, it's important to be able to replace it with one which is in the same beta spread to maintain proper circuit operation. All of this will become apparent in future columns when I talk about the operating point, and biasing transistor circuits.

### TRANSISTOR CUTOFF FREQUENCIES

A couple of columns ago, I mentioned the frequency response of transistor amplifiers. I talked mainly about the coupling and bypass capacitors which affect the amplifier response. There are several "cutoff frequencies" for any given transistor type and they affect the choice of transistors for any given circuit. As you might surmise, a cutoff frequency is the frequency where transistor efficiency as an amplifier begins to fall off. There are three basic cutoff frequencies. (1) the  $\alpha$  cutoff frequency,  $f_{\alpha}$ , (2) the  $\beta$  cutoff frequency,  $f_{\beta}$ , and (3)  $f_T$ , which is known as the gain-bandwidth product of the transistor.

The  $\alpha$  cutoff frequency,  $f_{\alpha}$ , is the frequency at which the  $\alpha$  has dropped to 0.707 of its low-frequency value. If, for instance, you have a transistor whose low-frequency  $\alpha = 0.99$ , and it has an  $f_{\alpha}$  of 2 MHz, then at 2 MHz  $\alpha$  will equal:

$$\alpha = 0.707 (0.99) = 0.7$$

This means that in a common-base circuit, the collector current will be only 0.7 times the emitter current. Thus, the transistor's "quality" is falling off rapidly. In other words, 2

MHz is the "3-dB down point" for this particular transistor.

The  $\beta$  cutoff frequency,  $f_{\beta}$ , is the frequency at which  $\beta$  drops to 0.707 of its low frequency value. Recall that there is a DC beta as well as an AC beta. The AC beta is the ratio of the small signal collector current to the small signal base current. If you keep the base current constant as you raise the frequency, the collector current will start to decrease at some frequency. When that frequency is the one at which  $\beta$  has decreased to 0.707 of its low-frequency value, it is known as the  $\beta$  cutoff frequency,  $f_{\beta}$ .

Since  $\beta$  is normally associated with the common-emitter stage, it is this value that you will find in manufacturer's spec sheets. On these sheets it is often labelled  $h_{fe}$ , with the small letters reminding you that it is an AC (or signal) parameter.

Finally,  $f_T$  is the frequency at which  $\beta = 1$ . For all practical purposes, this is the frequency at which the transistor no longer amplifies.

That is why it is called the gain-bandwidth product. If a transistor has an  $f_T$  of 300 MHz, then it has a gain of 1 at 300 MHz. At frequencies below 300 MHz, the value of  $\beta$  increases up to its low-frequency value and the transistor will provide more and more gain as the frequency is lowered.

Put another way, if you want a transistor to provide good gain at 30 MHz, choose one that has an  $f_T$  close to 300 MHz. This will keep it's  $\beta$  high, and should provide close to maximum performance from the transistor. To be sure, there are other factors involved in amplifier design and performance as the frequency is raised. Stray wiring capacitances, and internal transistor capacitances also affect a circuit's performance as the frequency is raised. Physical layout of a circuit becomes more critical as the frequency is raised, and I'll talk more about that later when we get into RF circuitry. \*\*\*

## W2HBE RECEIVER



*Built as a camper's companion for 1933, Bob Dennison, W2HBE, shows us a two-tube battery set designed to take to camp. The Companion includes six plug-in coils, headphones, a flashlight and all necessary accessories for the camper of 1933. A dial calibration chart is attached to the inside of one of the doors, showing the tuning range of each coil. The receiver tunes from 540 Kc to 19 Mc (remember Kc & Mc?), thus covering the 160, 80, 40 and 20 meter ham bands! (photo: W2HBE)*

# CLASSIFIED ADS

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Commercial or non-commercial subscribers, no minimum. All ads must be related to amateur radio. **Hambrew** does not vouch for nor guarantee the reliability nor legitimacy of any item or company represented herein. Deadlines: Sept. 1 (Autumn), Dec. 1 (Winter), March 1 (Spring) June 1 (Summer). We reserve the right to deny publication of any ad. Copy To: PO Box 260083, Lakewood, CO 80226-0083. Sorry, no phone orders on classified ads. Prepay only.

**Need Manual for Yaesu FT208R HT.** If available, please xerox and send a copy. Will pay for costs. Ken Mahoney, K6OPG, 2036 Revere Ave. San Francisco, CA 94121, (415) 282-4807

**J.W. Miller slug tuned ceramic inductors**, used in the old QST homebrew projects. Very limited supply! SASE for list. Jeffrey Viola, 784 Eltone Rd., Jackson, NJ 08527

**CHASSIS AND CABINET KITS:** #10 SASE 5120-H HARMONY GROVE RD., DOVER, PA 17315. 717-292-4901 EVENINGS

**2N4416A FETs for sale.** Prime/JAN devices in ESD pack 10/\$6.00 PPD to KCSRT, 701 Oakridge, Liberty, MO 64068

**For Sale: Collins RE Mechanical filters** F-455-FA27-6810 2.7Kc at 455KHz PC Mount (not plug in). \$27.50 ea., Postpaid. Henry Mohr, 1005 W. Wyoming St., Allentown, PA 18103

**The History of QRP in the U.S. 1924-60** by Ade Weiss K8EFG/WØRSP. 208 pages, 56 photos/16 illustrations-WIFB: "I recommend this book for your Amateur Radio library, even if you never become a member of the fast-growing QRP fraternity..." WB8UUJ: "something to warm the cold winter nights with good memories.." \$12/1st Class (\$10 Sen. Cts.) AdeWeiss, 526 N. Dakota St., Vermillion, SD 57069

**Help Needed** Converting VHF marine FM xcvrs to 2M ham band. One rig is binary PLL, MC145105, two other rigs are older and xtal type. Tnx. Jim Hale, KJ5TF, HC 65, Box 261-B, Kingston, AR 72742

**Builders! Hard-to-find ceramic rotary switches.** Ideal for bandswitching, antenna tuners, etc. Four wafers with single pole, five positions on each. Limited supply. \$5 postpaid. Limit one per person. Unfilled orders returned. Fred Bonavita, W5QJM, Box 2764, San Antonio, TX 78299-2764

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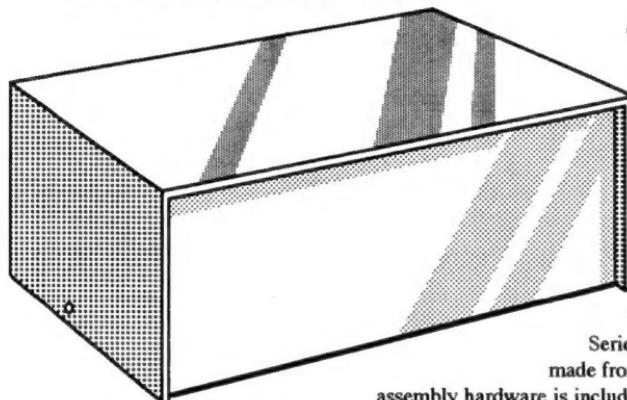
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